No.99MBA043A
SERIES No.302

PJ-A3000 Series

Measuring Projector

User's Manual

Read this User's Manual thoroughly
before operating the instrument. After reading,
retain it close at hand for future reference.

Mitutoyo

Conventions Used in this User's Manual

This section describes the symbols (safety warning symbols) used in this manual.

Safety Precautions

This manual uses various symbols to help you use this unit correctly, and prevent danger to personnel or equipment damage.

- The following symbols indicate **general** dangers, warnings and cautions.

DANGER	Indicates an imminently hazardous situation which, if not avoided, will result in serious injury or death.
WARNING	Indicates a potentially hazardous situation which, if not avoided, will result in serious injury or death.
CAUTION	Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury or property damege.

- The following symbols indicate **specific** warnings or prohibited actions.

	Alerts the user to a specific hazardous situation. The given example means “Caution, risk of electric shock”.
	Prohibits a specific action. The given example means “Do not disassemble”.

WARNING

■ Do not modify this instrument.
Risk of fire or electric shock.

■ Do not bend, twist, pull, or modify the power cord.
Risk of fire or electric shock.

■ Do not remove the front panel, rear panel, side panel or covers of this instrument.
Risk of electric shock.

■ Only operate this instrument at the specified voltage.
Risk of fire or electric shock.

■ Do not set up this instrument on an unstable bench.
The instrument may fall.
Risk of injury.

■ Do not place a vessel containing liquid near the instrument.
Risk of fire or electric shock.

■ Unplug the power cord and contact Mitutoyo if liquid has entered the instrument.
Risk of fire or electric shock.

■ Unplug the power cord if replacing a fuse.
Risk of electric shock.

■ The AC outlet incorporated with the instrument is only available for Mitutoyo accessories.
Do not plug in other equipment.
Risk of fire.

■ Should this system be used under abnormal conditions such as heat radiation, smoking, and nasty smell generation, there is a risk of fire or electric shock.
Immediately turn off the power switch, then unplug the power plug from the outlet.
Contact your dealer or the nearest Mitutoyo service network.

■ Unplug the power cord if performing maintenance.

■ Do not pull the cable to unplug the power cord.
Hold the plug and pull to prevent cord breakage.
Risk of fire or electric shock.

■ Do not connect/disconnect or touch the plug with wet hands.
Risk of electric shock.

■ Keep the power cord away from heaters.
Risk of fire or electric shock with melted cable insulation.

■ Only use the specified fuse.
Risk of fire or electric shock.

■ Do not block the ventilation outlets.
Risk of fire due to internal heat build up.

■ For quick power shutoff install this system at a site where the system power plug can be easily identified and quickly accessed to be unplugged.

CAUTION

■ Do not apply excessive force to the instrument.
Risk of instrument failure, damage, or decreased accuracy.

■ Only hold the specified parts of the instrument if transporting.
Risk of instrument failure, damage, or decreased accuracy.

■ Exercise care so as not to pinch or hurt your fingers if mounting/dismounting accessories.

■ Only use the accessories specified in the User's Manual provided with the instrument.
Risk of fire, electric shock, and instrument failure.

TIP

A *tip* is a type of note that helps the user apply the techniques and procedures

- ith the topic being

Mitutoyo assumes no liability to any party for any loss or damage, dir ect or indirect, caused by use of this instrument not conforming to thi s manual.
Information in this document is subject to change without notice.

© Copyright Mitutoyo Corporation. All rights reserved.

Handling Precautions

1. Confirm the input voltage before turning the power switch on

For the input voltage of this microscope, there are two systems of 100V-system (100 to 120V) and 220V-system (220 to 240V). Connect the power plug with the plug socket after confirming that the rated voltage of the microscope corresponds with the voltage of plug socket.

2. Turn the power switch ON or OFF along the order

The counter may display error messages (E51, E52, E53) by the order which turns the power supply of the microscope main unit and the peripheral equipment such as personal computer on or off in the connection with some peripheral equipment, when the peripheral equipment is being connected with the counter unit at RS232C.
Be sure to perform at the following order, when turning the power switch ON or OFF.

- For ON ····· **Peripheral equipment ➔ Projector main unit**
- For OFF ···· **Projector main unit ➔ Peripheral equipment**

3. Only use the specified power cord and fuse

Use only the supplied power cord. Replacement fuses must be of the specified type, voltage and current.

4. Do not disassemble

Disassembly of any unit or removal of panels may present a hazard to personal or result in a unit failure. Never attempt to disassemble, unless absolutely essential, e.g. for the replacement of a fuse, etc..

This instrument consists of precision components, and its performance cannot be guaranteed, even within the warranty period, if it is disassembled by the user.
All equipment failures that occur after user disassembly will be repaired on a fee-for-service basis.

Guarantee

This system has been manufactured under Mitutoyo's rigorous quality control system. In the event that it proves defective in workmanship or materials within one year of the date of purchase under normal usage, Mitutoyo will repair the instrument free of charge. Contact your dealer or nearest Mitutoyo Service Center.

This guarantee does not apply to the following cases:

- Equipment failure or damage due to incorrect usage or unauthorized modification or repair.
- Equipment failure or damage resulting from moving, transporting, or dropping the instrument.
- Equipment failure or damage due to fires, salt damage, gas damage, abnormal voltages, or natural disasters.

CONTENTS

Conventions Used in this User's Manual 1
Safety Precautions 1
On Various Types of Notes 5
Handling precautions 6
Guarantee 6

1. Overview 1-1
1.1 Outline 1-1
1.1.1 Name of Each Part 1-1
1.1.2 Control panel 1-2
1.1.3 Angle counter and X, Y counter 1-3
1.1.4 Power panel 1-4

2. Installation and Setup 2-1
2.1 Installation 2-1
2.1.1 Environmental Conditions 2-1
2.1.2 Transportation and installation 2-2
2.1.3 Setting up the main unit 2-3
2.1.4 Removing the carrying handles 2-3
2.2 Assembly 2-4
2.2.1 Installing the cross-travel stage and Digimatic Head (for PJ-A3005D-50) 2-4
2.2.2 Installing the cross-travel stage and connecting the Linear Scale cables (PJ-A3010F-200). 2-7
2.2.3 Connecting the Optoeye A2 Image Edge Sensor（for PJ-3010F-200） 2-9
2.2.4 Mounting the projection lens 2-10
2.2.5 Setting the power voltage 2-10
2.2.6 Connecting the power cord 2-11
2.3 Initial Checks (Functional Check) 2-12
2.3.1 Electrical component connectors 2-12
2.3.2 Main switch (ON-OFF) 2-12
2.3.3 Switches for Contour illumination and reflected illumination 2-12
2.3.4 Focusing wheel 2-12
2.3.5 Cross-travel stage 2-13
2.3.6 Projection screen 2-13
2.3.7 Others 2-13
2.4 Initial Checks (Performance Check) 2-14
2.4.1 Checking the position of the contour illumination bulb filament 2-14
2.4.2 Checking the position of the surface illumination bulb filament 2-14
2.4.3 Projection with contour illumination 2-16
2.4.4 Projection with reflected illumination 2-17
2.4.5 Color fitter 2-18
2.4.6 Checking the magnification accuracy 2-19
2.4.7 Checking the cross-travel stage travel direction 2-21
2.4.8 Checking the cross-travel stage feed error 2-23
2.4.9 Checking the resolution (in contour illumination mode) 2-23

2.5 Adjustment 2-24
2.5.1 Adjusting the magnification 2-24
2.5.2 Aligning the cross-travel stage travel direction to the cross-hair lines 2-24
2.5.3 Centering the protractor screen 2-24

3. Operation 3-1
3.1 Projection Lens Selection 3-1
3.1.1 Selecting the projection lens 3-1
3.1.2 Replacing the projection lens 3-2
3.2 Mounting the Workpiece 3-2
3.3 Focusing and Positioning the Workpiece 3-4
3.3.1 Focusing 3-4
3.3.2 Positioning the workpiece 3-5
3.4 Measurement and Inspection 3-6
3.4.1 Rectangular coordinate measurement (with the X, Y counter) 3-6
3.4.2 About parameters 3-9
3.4.3 Dimensional measurement using a scale 3-15
3.4.4 Comparison with an overlay chart 3-15
3.4.5 Angle measurement (Using the Angle counter) 3-16

4. Troubleshooting 4-1
4.1 Main Unit 4-1
4.2 Counter Unit 4-2
4.3 Error Messages and Remedies 4-3
4.4 Others 4-3
4.4.1 Error is observed in glass scale or overlay chart measurement 4-3
4.4.2 Abnormal cross-travel stage operation, and measurement errors occur 4-3
4.4.3 Abnormal protractor screen operation 4-4
4.4.4 Partial obscured image 4-4
4.4.5 Digimatic Head Key Operation and Counter Display (for PJ-A3005D-50) 4-4

5. Maintenance 5-1
5.1 Maintenance of Optical Components 5-1
5.1.1 Projection lens 5-1
5.1.2 Half-reflecting mirror for surface illuminator 5-1
5.1.3 Mirror(surface reflecting mirror) 5-1
5.1.4 Screen glass 5-1
5.2 Maintenance of Mechanical Components 5-2
5.2.1 Projector main unit 5-2
5.2.2 Cross-travel stage 5-2
5.3 Replacing Disposable Parts 5-3
5.3.1 Bulbs for contour and surface illuminators 5-3
5.3.2 Fuse 5-5
5.3.3 Stage glass 5-6
5.4 Periodic Inspection 5-6
5.5 List of Consumable 5-7

6. Specifications 6-1
6.1 General 6-1
6.1.1 Common Specifications 6-1
6.1.2 Individual specifications 6-3
6.1.3 Date output（RS232C） 6-4
6.1.4 Connector specifications 6-4
6.1.5 Data output operation 6-6
6.1.6 Connecting Micropak 6-9
6.1.7 Connecting QM-Data 200 6-10
6.1.8 Data output (SPC) 6-10
6.2 Performance Table for the PJ-A3000 Series Projectors 6-14
6.3 Optical Path 6-15
6.4 External dimensions 6-16
6.4.1 Main Unit 6-16
6.4.2 Cross-travel stage 6-19
6.5 Accessories 6-21
6.5.1 Standard accessories 6-21
6.5.2 Optional accessories 6-22

SERVICE NETWORK

MEMO

1 Overview

This chapter describes the system outline, and the name and function of each part on the PJ-A3000 series Measuring Projector.

1.1 Outline

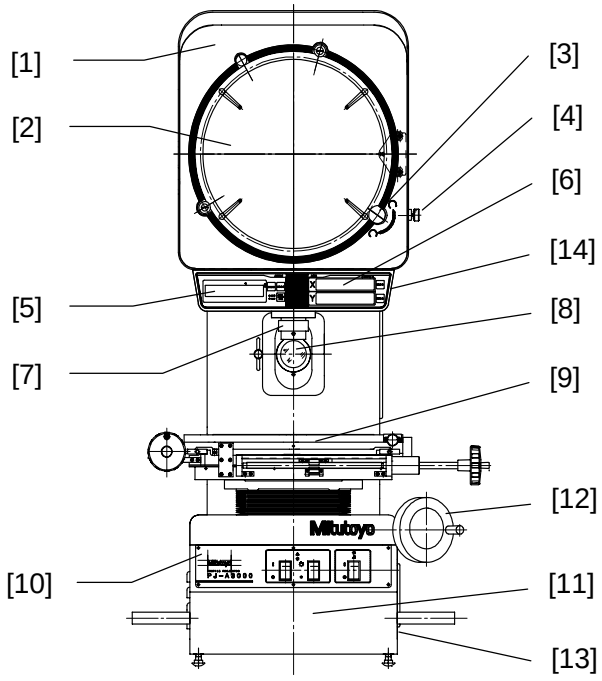
The Mitutoyo PJ-A3000 series Measuring Projector is a multi-purpose measuring microscope for factory inspection use. It can perform precision measurement of workpiece dimensions, contours and surface features.

The PJ-A3000 series can be used in a wide range of applications in combination with a variety of accessories. It is possible to improve the system according to a specific purpose.

The MF-A series has the following features.

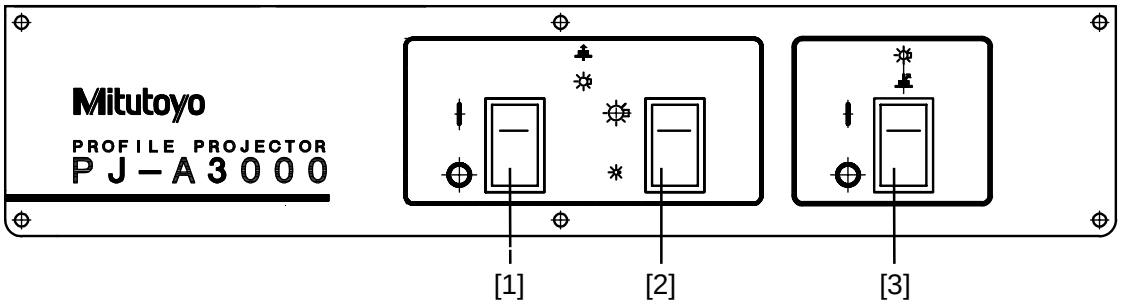
- The cross-travel stage with a maximum stroke of 200 X 100mm is available as an option.
- For the counter display, the readout is easy since the characters are large.
- For the counter display unit, following three types are prepared ; angle and X,Y-axis/ only angle/ no display
- For both the contour and the reflective light source unit, the halogen bulb of 500 hours life with 24V and 150W is used.
- By the slide switching mechanism, the quick bulb exchange is possible.
- The operability is improved still more, because each switches are placed at the front and right side of main unit.

1.1.1 Name of Each Part



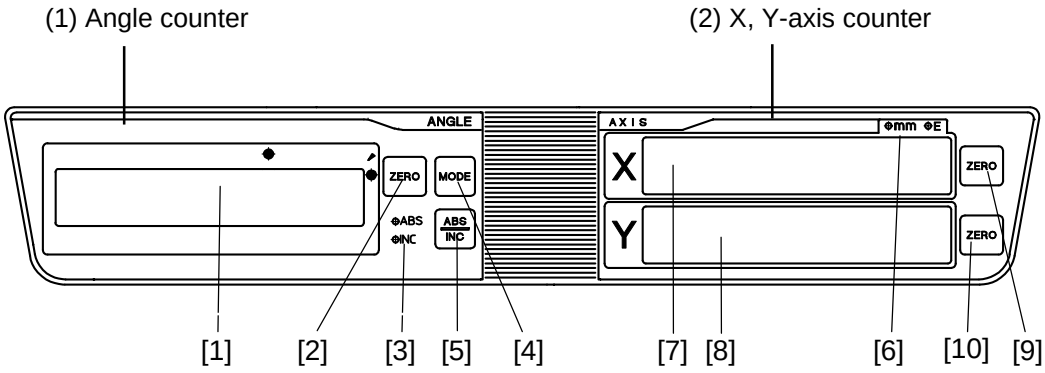
[1] Projector head
[2] Projection screen
[3] Screen rotating knob
[4] Screen clamp knob
[5] Angle counter
[6] XY counter
[7] Projection lens
[8] Reflected illuminator, Condenser lens for reflected illuminator
[9] Cross-travel stage
[10] Control panel
[11] Contour illuminator (interior)
[12] Focusing wheel
[13] Power panel
[14] XY counter output connector

1.1.2 Control panel



[1] Main switch (Power switch) (| :ON / O:OFF)
[2] Contour illumination brightness selector switch
[3] Reflected illumination switch (| :ON / O:OFF)

1.1.3 Angle counter and X, Y counter



(1) Angle counter

[1] Angle display unit

[2] Zero-set key

[3] ABS/INC mode indicator

[4] Angle unit selector / offset switch

[5] ABS/INC mode selector switch

(2) X, Y-axis counter

[6] mm/E indicator or inch/mm indicator

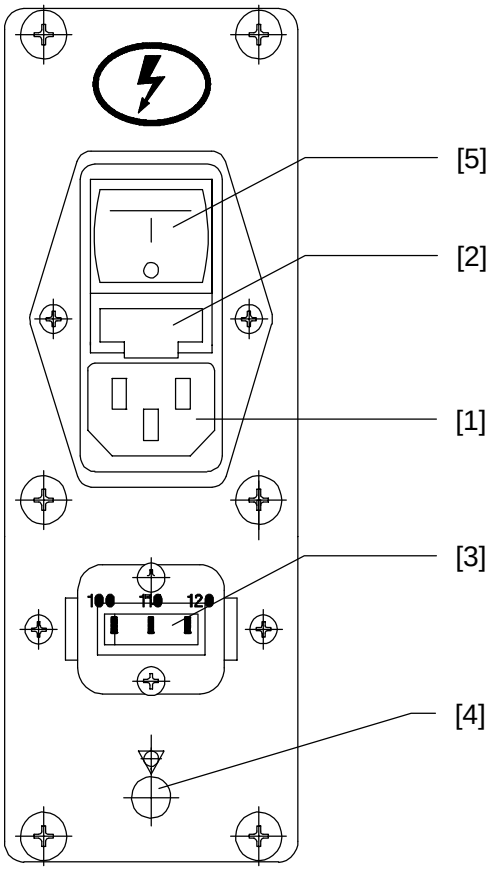
[7] X-axis counter

[8] Y-axis counter

[9] X-axis zero-set switch

[10] Y-axis zero-set switch

1.1.4 Power panel (Right lateral front part of main unit)



[1] Plug socket
[2] Fuse holder
[3] Voltage selector
[4] GND terminal
[5] Power switch

2 Installation and Setup

This chapter describes the installation environments and connection method of the PJ-A3000 series Measuring Projector.

2.1 Installation

2.1.1 Environmental Conditions

2.1.1.1 Temperature

The PJ-A3000 series Measuring Projector has been assembled and adjusted at 20°C in a temperature controlled room. To ensure the rated measuring accuracy, the temperature at the installation site must be maintained as close to 20°C as possible, with minimal fluctuation. (For reference, the conditions specified by JMAS5011 are: 20°C ± 1°C with a temperature gradient of less than 2°C per 8 hours.) In poor temperature conditions, the accuracy performance may not be satisfied. It is illegal to make any machine adjustments affecting the accuracy at ambient temperatures other than 20°C. After such adjustment, accuracy is no longer guaranteed at 20°C.

2.1.1.2 Humidity

Humidity will not affect the measuring accuracy directly. However, high humidity may corrode machined surfaces and may adversely affect electronic parts. The environmental humidity should be maintained within a range of 55% to 65%RH.

2.1.1.3 Dust and dirt

The PJ-A3000 series Measuring Projector consists of high-precision parts, including guide faces, linear scale units, and optical unit, that must be kept free of dust and dirt. Use and store the PJ-A3000 series Measuring Projector in a place where it will not be subjected to dust and dirt.

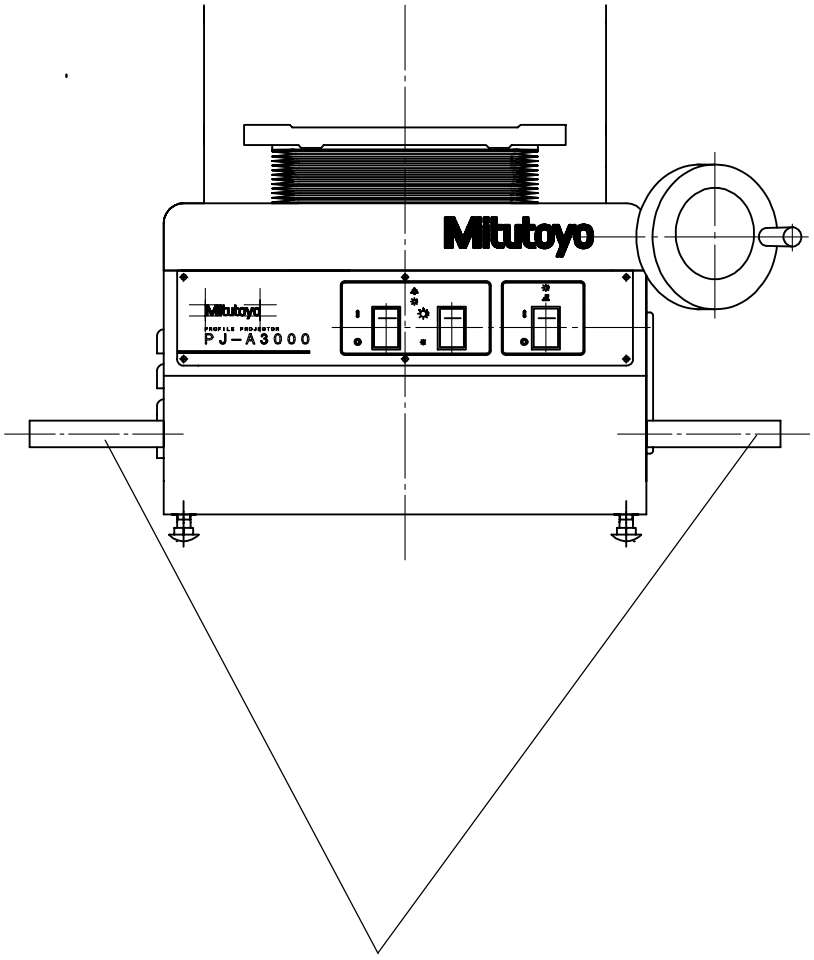
2.1.1.4 Grounding

Connect the ground terminal with the ground terminal of grounding resistance 100 Ω or less so that the measuring microscope may normally operate.

TIP On the **Reinstallation •••••** The projector main unit reinstallation performed on the client's own may deteriorate the required accuracy due to vibrations and shocks during transportation. Therefore, it is recommended that the main unit be reinstalled by Mitutoyo. If the system is desired to be reinstalled, be sure to contact the Mitutoyo sales office.

2.1.2 Transportation and installation

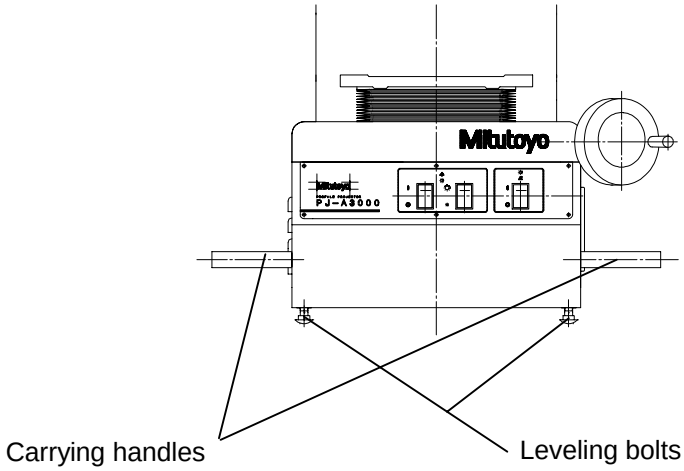
Be sure to use the supplied carrying handles when handling, shifting or installing the projector and due to its heavy weight (for PJ-A3010F-200, about 120kg) four people are required to carry it. The PJ-A3000 series has been fully adjusted at the plant, therefore take special care when handling and setting up the projector so that no part of the projector is subjected to impact or vibration.



Carrying handles

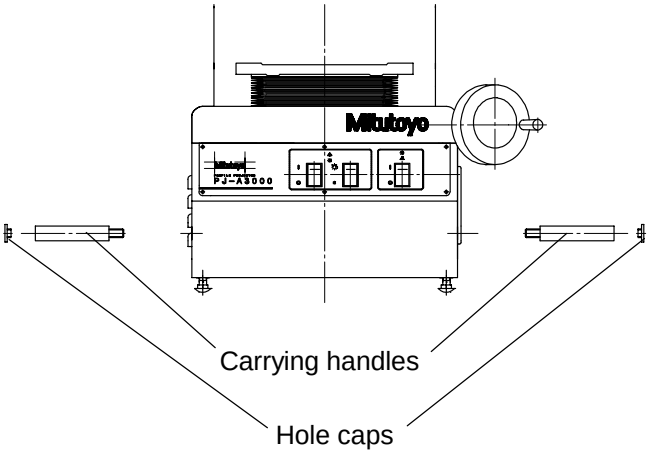
2.1.3 Setting up the main unit

The projector must be set up on the optional stand or a rigid, stable mount. Use the leveling bolts on the projector base to compensate for any inclination.



2.1.4 Removing the carrying handles

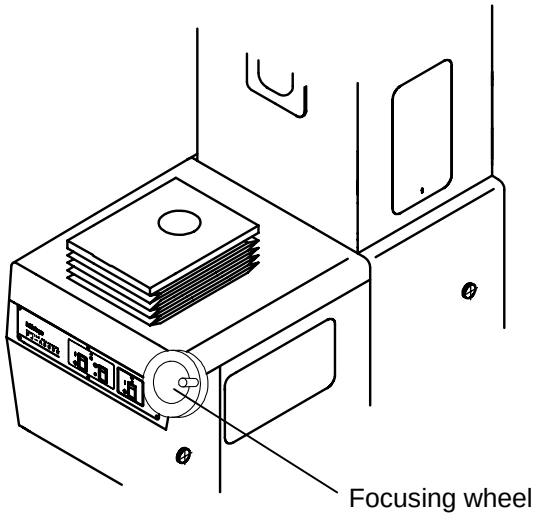
After setup, remove the carrying handles and cover the screw holes with the supplied hole caps.



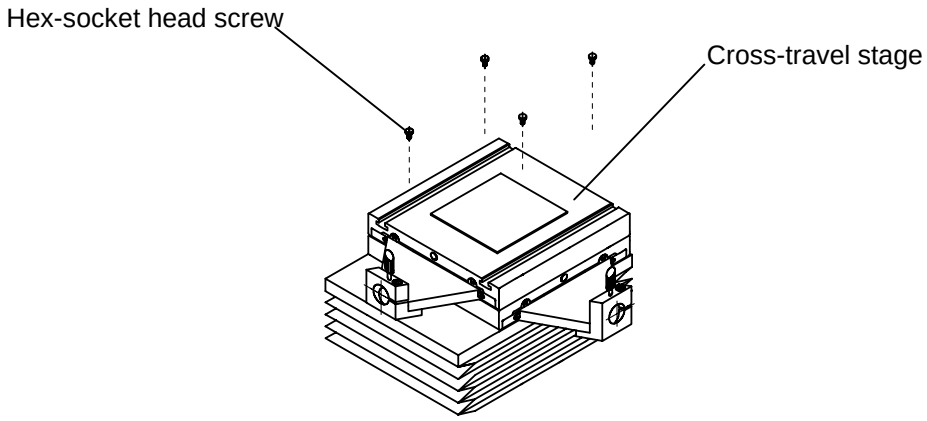
2.2 Assembly

2.2.1 Installing the cross-travel stage and Digimatic Head (for PJ-A3005D-50)

1. Turn the focusing wheel clockwise to lower the cross-travel stage mount down to the end of its displacement.



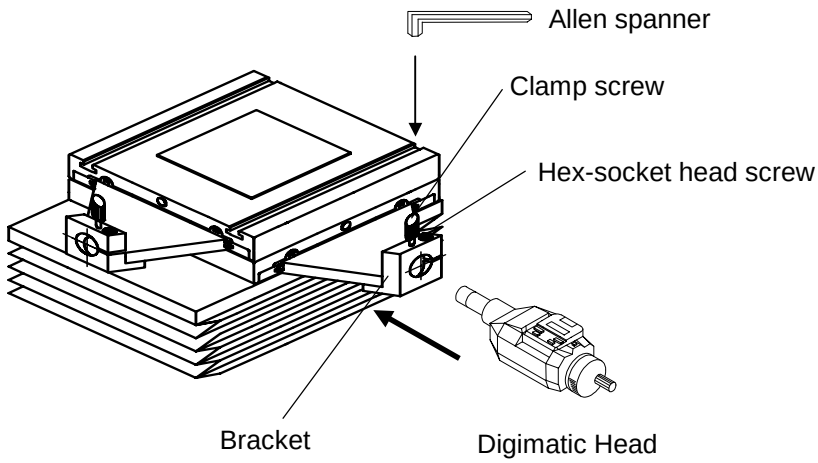
2. Gently place the cross-travel stage on the mount. Slide the moving sections to the left and right to check the screw hole positions, then use the four hex-socket head screws (supplied in the standard accessory box) to temporarily fix the cross-travel stage in place.



TIP The cross-travel stage should be secured when the adjustment of its travel direction is complete. (Refer to 2.5.2 Aligning the cross-travel stage travel direction to the cross-hair lines.)

3. Installing the Digimatic Head

- Loosen the clamp screw and hex-socket head screw on the bracket.
- Slowly insert the stem of the Digimatic Head into the bracket as far as it can go, then secure it in place with the hex-socket head screw. Do not fasten the screw too tight, otherwise the spindle of the Digimatic Head will not move smoothly.

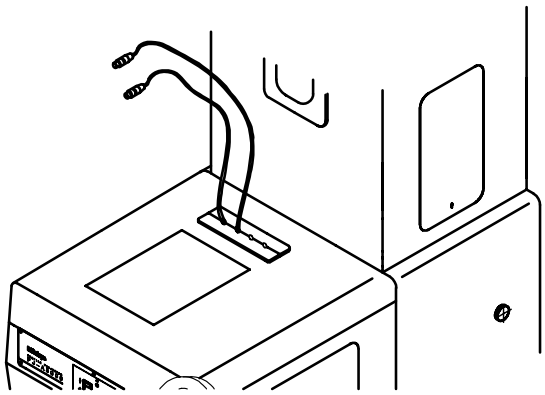


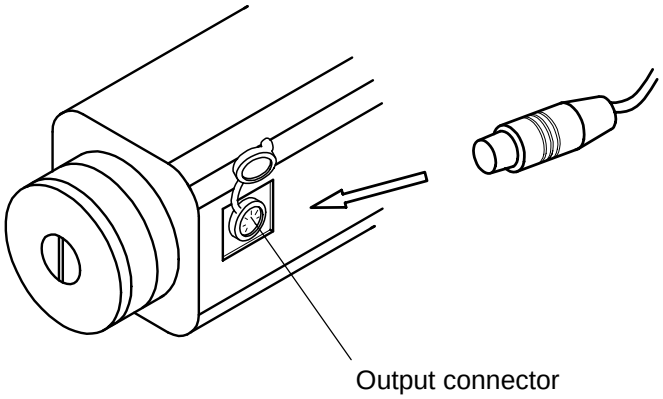
TIP

- When using a Digimatic Head or other types of heads that are not provided with a hole to clamp the spindle, the clamp screw is not used to secure it, lightly fasten the screw.
- The Micrometer Head is provided with a hole for damping the spindle. Align this hole with the clamp screw. If the display is not in a good viewing position, loosen the clamp screw on the Micrometer Head sleeve, and adjust the display position.

4. Connecting the Digimatic Head cables (for PJ-A3005D-50)

Remove the dust-prevention cap from the output connector on a side of the Digimatic Head. Connect the cable for the counter to the output connector.

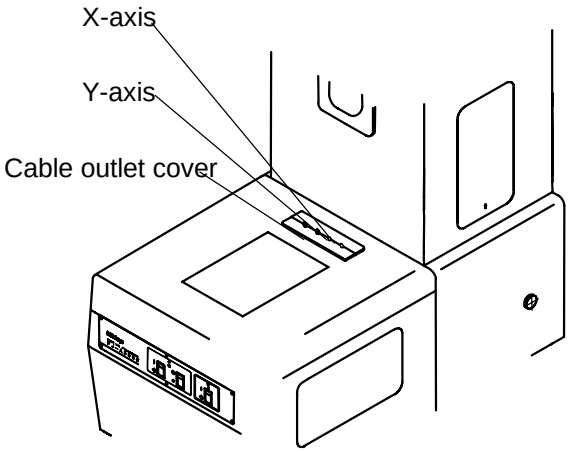




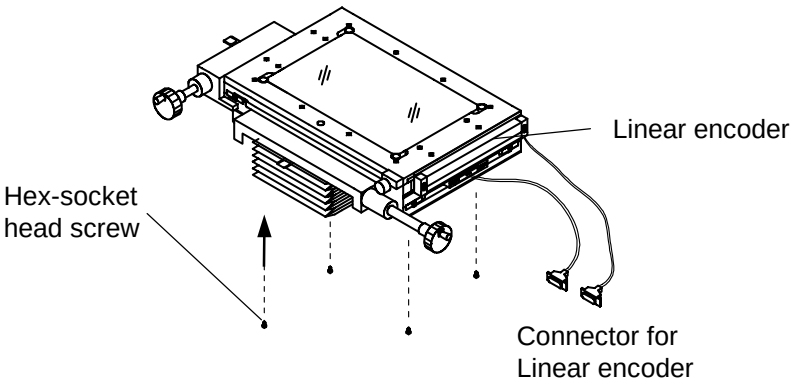
NOTE **Confirm sufficiently to connect so that the connection of X-axis and Y-axis may be not wrong.**

2.2.2 Installing the cross-travel stage and connecting the Linear Scale cables (for PJ-A3010F-200)

1. Remove the cable outlet cover.



2. Gently place the cross travel stage on the cross travel stage mount. Slide the moving parts to the left and right to align the screw holes, then use the four hex-socket head screws supplied to temporarily fix the cross travel stage in place.

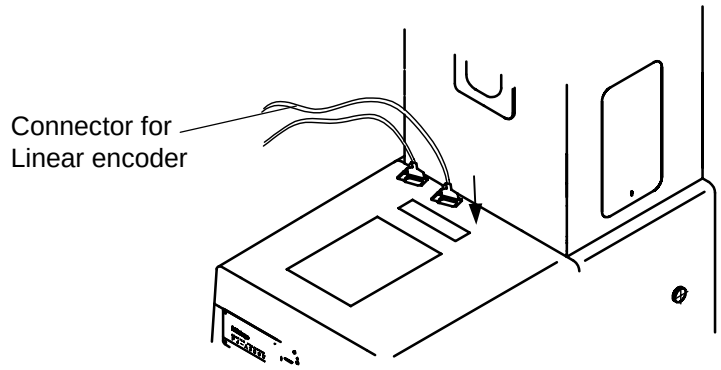


3. Rotate the focusing wheel to raise the cross-travel stage as far as it will go.

4. Place the linear encoder connector into the projector.

5. Connect the signal cables from the circuit board in the projector to the connector.

6. Attach the cable outlet cover.



TIP The cross-travel stage should be secured when the adjustment of its travel direction is complete. (Refer to “2.5.2 Aligning the cross-travel stage travel direction to the cross-hair lines”.)

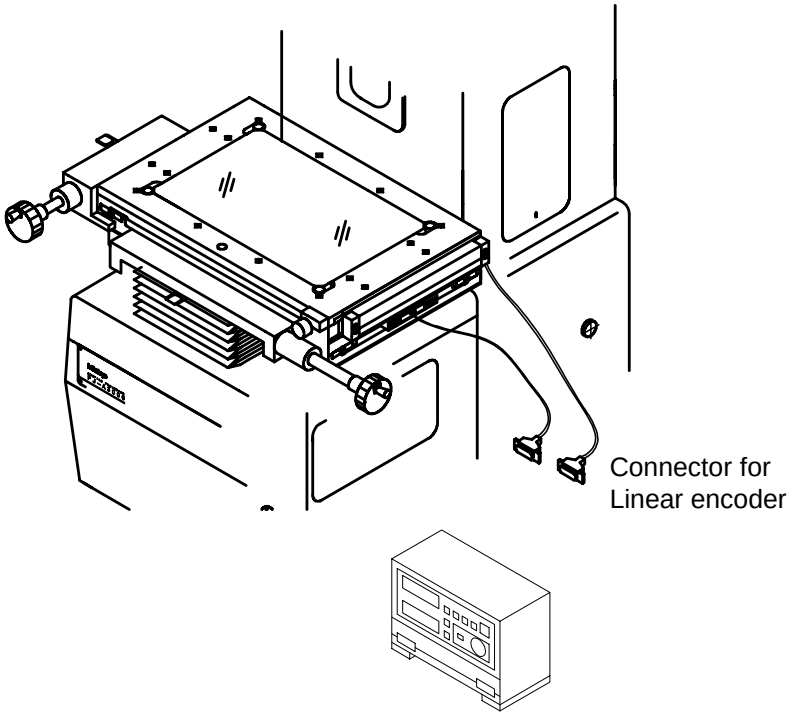
2.2.3 Connecting the Optoeye A2 Image Edge Sensor for PJ-3010F-200

1. Remove the cable outlet cover.

2. Disconnect the linear encoder connectors from the P.C.B inside the Profile Projector.

3. Attach the cable outlet cover.

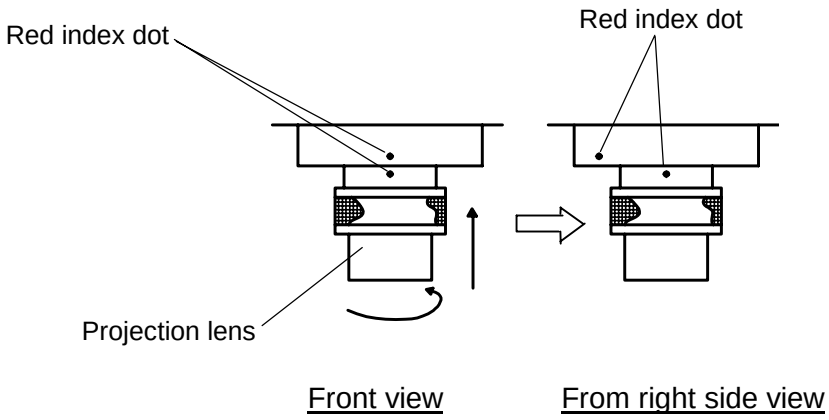
4. Connect the linear encoder connectors to the Optoeye A2 Counter.



2.2.4 Mounting the projection lens

1. Remove the lens mount cap and the projection lens cap.

2. Hold the lens so that the red index dot of the projection lens faces you. Align the index dot of the projection lens with that of the lens mount, push the projection lens upwards, then rotate the lens clockwise approximately 60° until the lens stops.

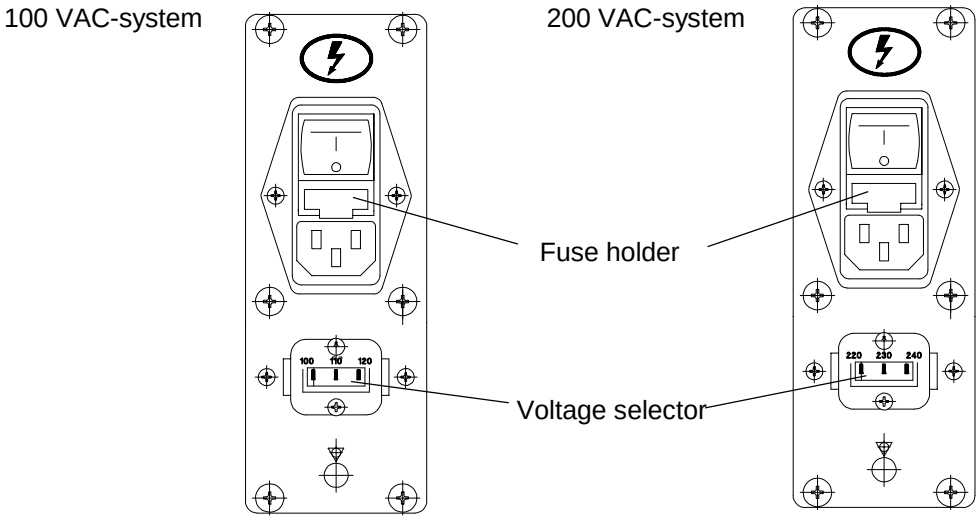


2.2.5 Setting the power voltage

Set the voltage selector plug to the supply voltage as follows.

CAUTION

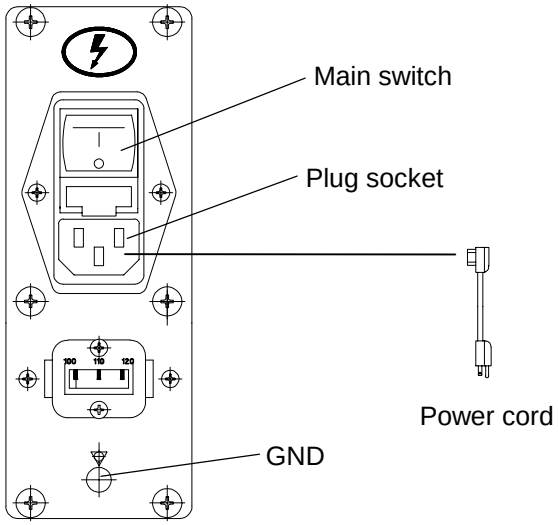
- **Be sure to unplug the power cord before setting the voltage selector.**
- **Set the voltage selector at the rated voltage.**



2.2.6 Connecting the power cord

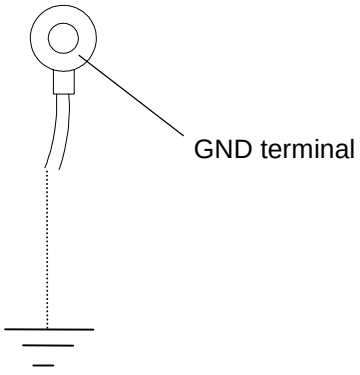
1. Turn off the main switch.

2. Connect the power cord to the power panel and plug it into the power outlet.



CAUTION

- **Use the power cord supplied with the projector.**
- **Use the GND terminal for grounding.**



2.3 Initial Checks (Functional Check)

Each projector is factory-inspected and adjusted, and has been safeguarded at all stages of shipment and transport, but prior to first time use, perform the following checks.

NOTE **While checking cables, make sure that all switches are tuned OFF.**

2.3.1 Electrical component connectors

Make sure that the power cord, plug socket, voltage selector, power switch, and GND terminal are securely connected.

2.3.2 Main switch (ON-OFF)

- Does the switch operate normally?
- Does the fan motor operate?

2.3.3 Switches for Contour illumination and reflected illumination

Contour illumination switch : OFF➔ON
Contour illumination brightness selector : HIGH➔LOW
Reflected illuminator switch : OFF➔ON

- Do the switches operate normally?
- Do the illumination bulbs turn on?
- Does the brightness change normally?

2.3.4 Focusing wheel

Turn the wheel.

- Is there any play or noise?

2.3.5 Cross-travel stage

- Is the stage glass clean and free of scratches?

Move the stage by hand over its full range.

- Does it move smoothly?
- Is there any play or noise?

(Use the Micrometer Head to move the cross-travel stage and check the above points.)

2.3.6 Projection screen

- Is the screen glass clean and free of scratches?
- Do the fine adjustment knob, clamp and chart clips work correctly?

2.3.7 Others

- Check the other parts of the projector and accessories for appearance and functionality. (Refer to "5.Maintenance" in case of any malfunction.)

2.4 Initial Checks (Performance Check)

2.4.1 Checking the position of the contour illumination bulb filament

1. Carefully remove the projection lens.

2. Turn on the power switch and contour illumination switch to project the filament of the contour illumination bulb on the screen.

3. Confirm that the filament image is projected in the approximate center of the screen.

2.4.2 Checking the position of the surface illumination bulb filament

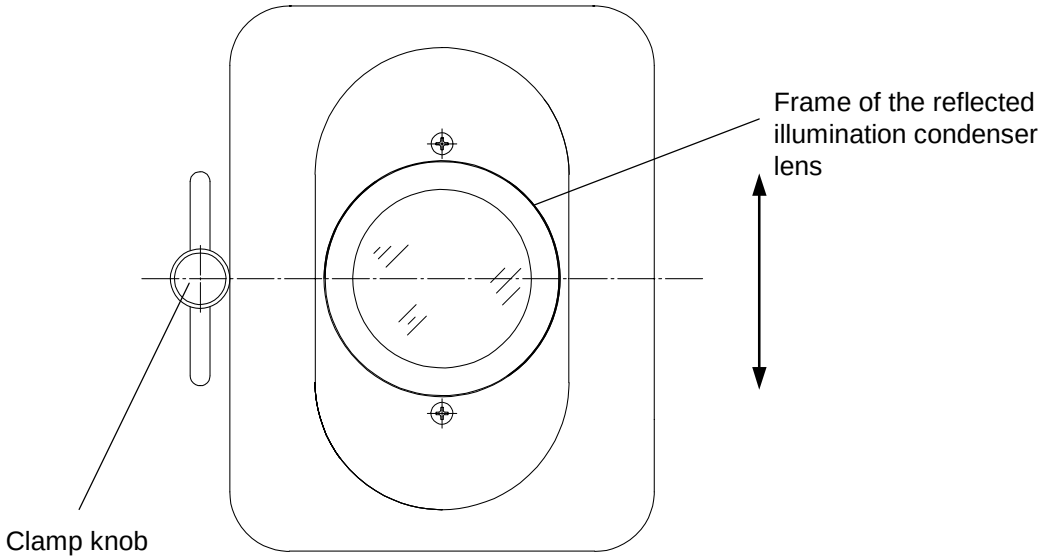
1. Carefully remove the projection lens.

2. Rotate the frame of the surface illuminator condenser lens clockwise until it is fully inserted.

3. Place the half-reflecting mirror (for 10x or 20X lens) on the cross-travel stage. Adjust the mirror position so that the light from the reflected illuminator is reflected at right angles. Adjust the reflected illuminator position so that the light beam is directed at the center of the mirror.

4. Turn on the main switch and contour illumination switch to project the filament of the contour illumination bulb on the screen.

5. Confirm that the filament image is projected in the approximate center of the screen.

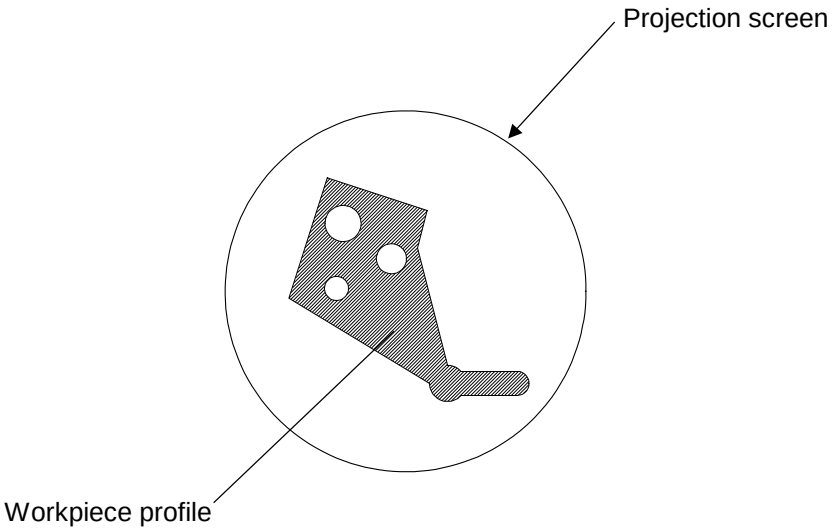


- For the vertical position adjustment of reflected illuminator, loosen the clamp knob to adjust with the clamp knob or the frame of reflected illumination condenser lens.

2.4.3 Projection with contour illumination

1. Turn on the contour illumination bulb.
(Use the brightness selector switch (HIGH and LOW) to select the light intensity.)

2. The workpiece profile is projected on the screen.



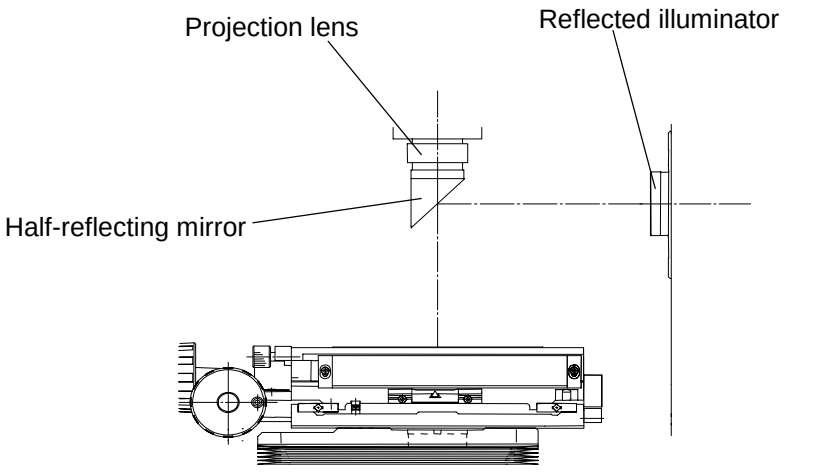
2.4.4 Projection with reflected illumination

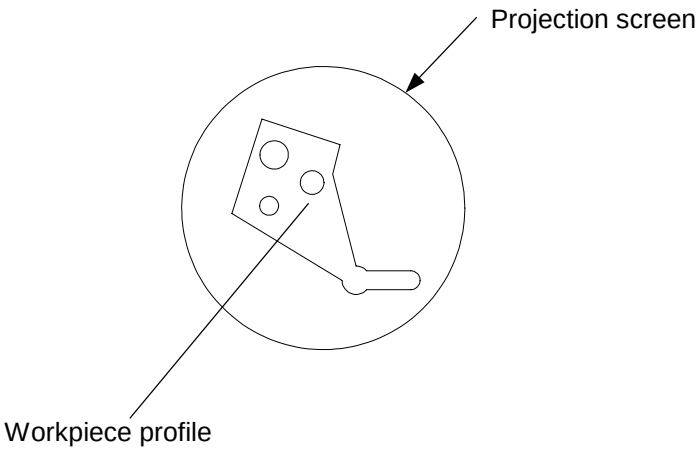
1. Turn on the reflected illumination bulb.

2. The image of the workpiece surface is projected on the screen.

3. Mount the half-reflecting mirror at the top of the projection lens frame so that the mirror is aimed towards the surface illuminator, as shown below. Use the frame of the reflected illumination condenser lens or the clamp knob to adjust the height of the reflected illuminator so that the light beam is directed to the surface of the workpiece.

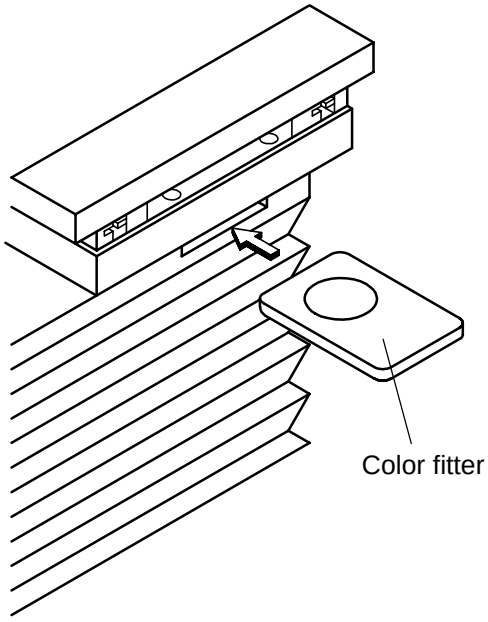
NOTE **Refer to Note in p.2-15 for the operation of the vertical position adjustment of reflected illuminator.**





2.4.5 Color fitter

This filter reduces eye fatigue. See the following for the insertion method.



Main unit left side

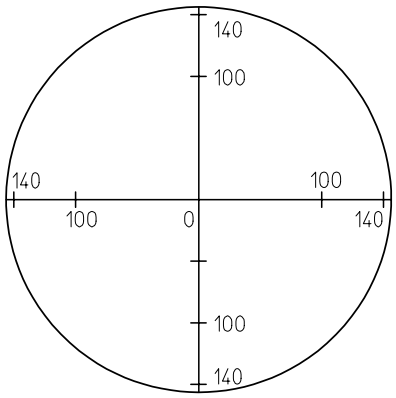
2.4.6 Checking the magnification accuracy

1. Mount the projection lens. (Refer to “2.2.4 Mounting the projection lens”)

2. Place a standard scale (optional accessory, No. 172-116) on the cross-travel stage to project its image on the screen.

3. Measure the projected image of the standard scale on the screen using a reading scale (optional accessory, No. 172-161).

4. Take measurements at two reference points (100mm, 140mm) in four or more radial directions along the cross-hair lines on the screen.



5. Calculate the magnification error using the following formula.

$$\Delta M = \frac{L - lM}{lM} \quad X\ 100\ \%$$

ΔM : magnification error

L : measured length of the standard scale

l : length of the standard scale

M : magnification of the projection lens

The magnification error is specified as ±0.1% or less for contour illumination, and the tolerance for each measured point is tabulated below. (If the magnification error for contour illumination falls within the tolerance, that for reflected illumination will also fall within the specified tolerance of ±0.15%)

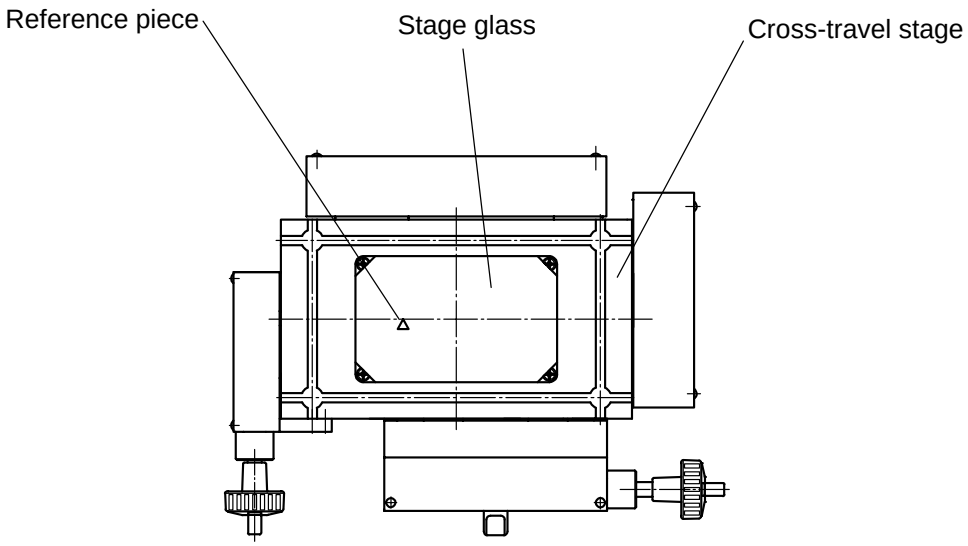
Measured point (on the reading scale)	**Tolerance**	**Permissible range**
100 mm	±0.1 mm	**99.**9-100.1 mm
140 mm	±0.14 mm	139.86-140.14 mm

TIP A positive error, i.e. where ΔM is a positive value, means that the measured length L is larger than the normal size (l×M), and vice versa for a negative error.

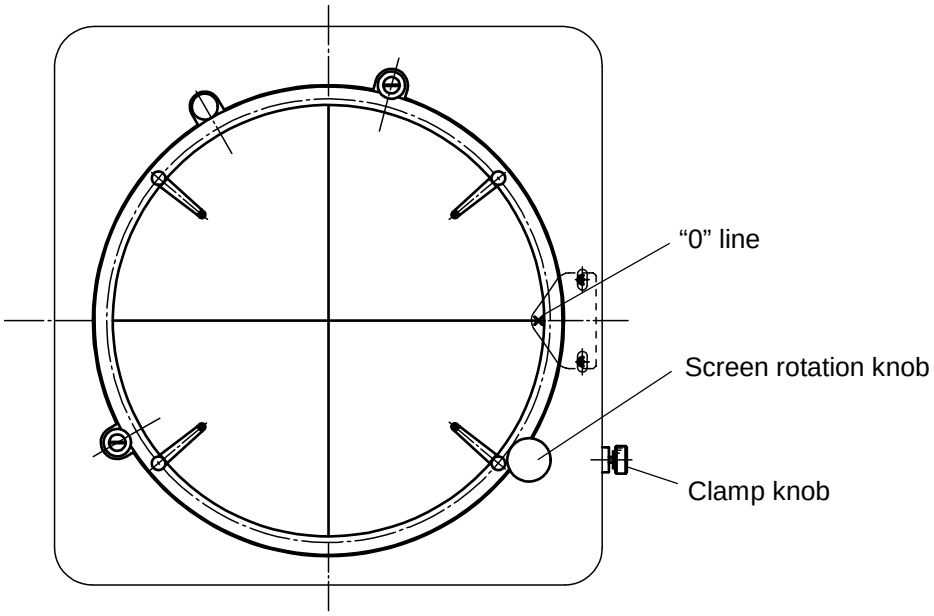
2.4.7 Checking the cross-travel stage travel direction

1. Mount the least magnified projection lens.

2. Place a reference piece on the stage to project its image on the screen.

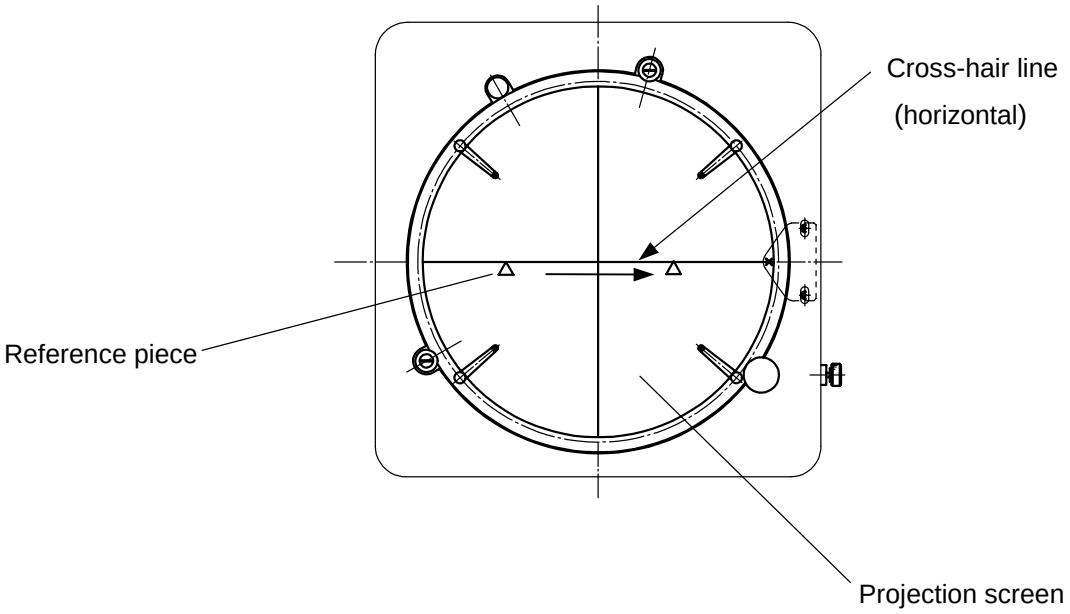


3. Set the protractor screen reference line to "0".



4. Move the cross-travel stage along the Y-axis (back and forth), and align the edge of the reference piece with the horizontal cross-hair line.

5. Move the cross-travel stage along the X-axis (left and right), and confirm that the edge of the reference piece is aligned with the horizontal cross-hair line over the entire length of stage X-axis travel.



- If a deviation from the horizontal cross-hair lines is observed, refer to 2.5 Adjustment for remedy.

2.4.8 Checking the cross-travel stage feed error

If the stage moves normally in 2.4.7, checking of feed error over a 5 mm travel may be sufficient. In this checking, many factors must be taken into consideration, including environmental conditions and alignment error.
Any feed error should be less than 0.01 mm per 5mm of travel.

1. Mount a projection lens.
2. Place a standard scale or other reference of known size on the cross-travel stage to project its image on the screen.
3. Feed the stage and determine the feed error by measuring the standard scale along the X-axis (left-right) and Y-axis (front-rear).
4. Check the feed error in the opposite travel directions (i.e. returning directions) for both X- and Y-axes.

- Contact Mitutoyo if the error is excessive.

2.4.9 Checking the resolution (in contour illumination mode)

1. Mount a projection lens.
2. Place a workpiece on the cross-travel stage and project its image on the screen. Ensure that the image is clear over the entire screen without any obscured regions.

- Refer to 4.4.4 if an obscure region is present.

2.5 Adjustment

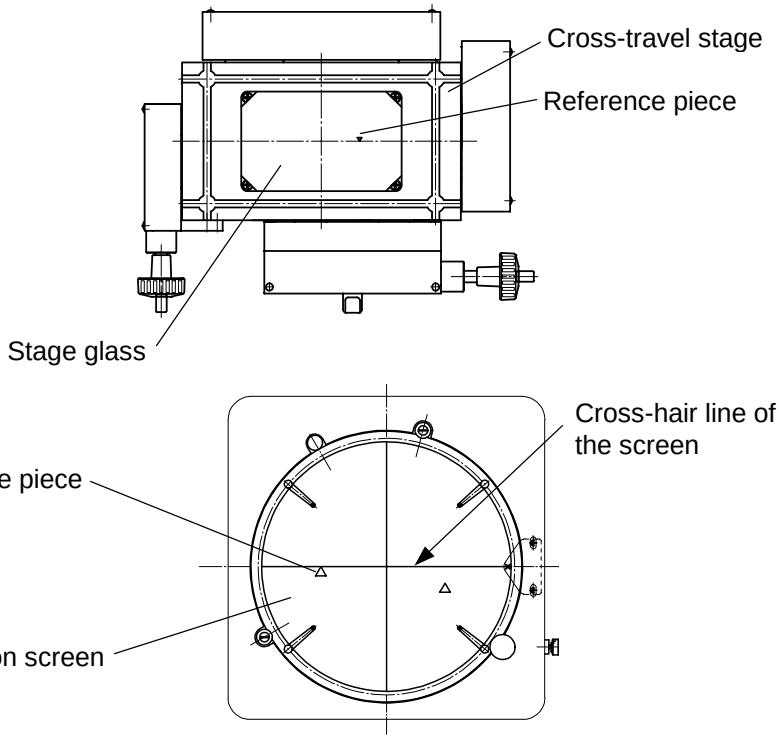
Read this section as required after reading “2.3 Initial Checks (Function Check)” and “2.4 Initial Checks (Performance Check)”.

2.5.1 Adjusting the magnification

Magnification adjustment requires experience. When the adjustment of a projection lens is required, contact Mitutoyo for assistance.

2.5.2 Aligning the cross-travel stage travel direction to the cross-hair lines

1. With the cross-travel stage mounting screws fastened but not tightened, carefully swivel the stage so that the reference piece does not deviate from the horizontal cross-hair line of the screen while feeding the stage in the X-axis direction.



2. When the adjustment is complete, tighten the stage mounting screws. Re-check the stage travel direction.

2.5.3 Centering the protractor screen

- This adjustment is performed by Mitutoyo service personal.

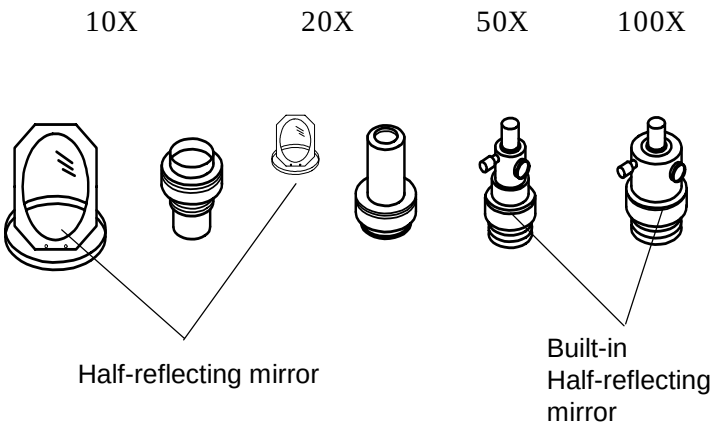
3 Operation

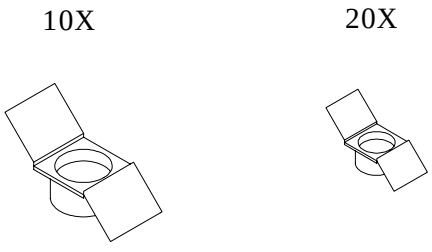
This chapter explains the setup for measurement including the optical system installation and workpiece set-up.

3.1 Projection Lens Selection

3.1.1 Selecting the projection lens

Select the appropriate projection lens magnification according to the required field of view, measuring method and accuracy requirements. (Refer to “6. Specifications”.)





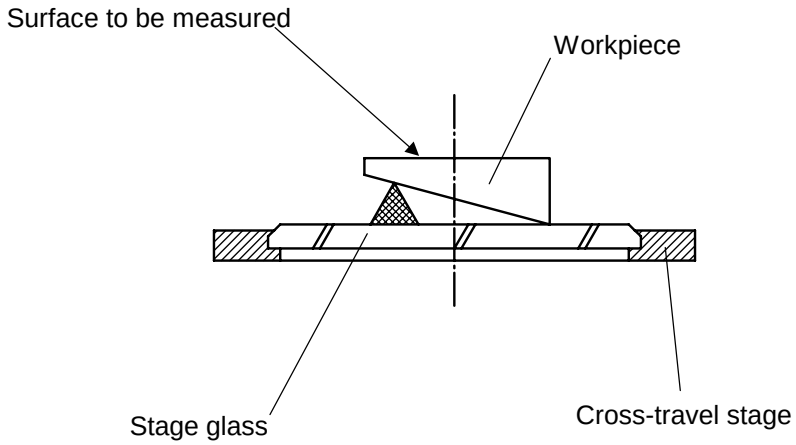
3.1.2 Replacing the projection lens

This projector has adopted the fixed focus lens to 10X to 100X.
When replacing the projection lens in order to change the magnification, it is required to switch the condenser lens according to the magnification of projection lens.

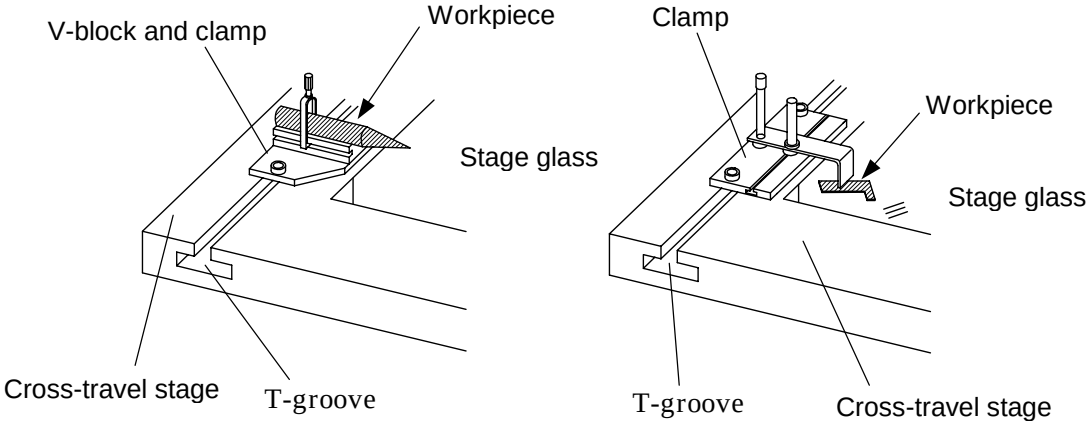
3.2 Mounting the Workpiece

Mount a workpiece on the stage glass or use a fixture or a jig to hold it in position. Use the T-grooves for securing fixtures and jigs to the cross-travel stage.

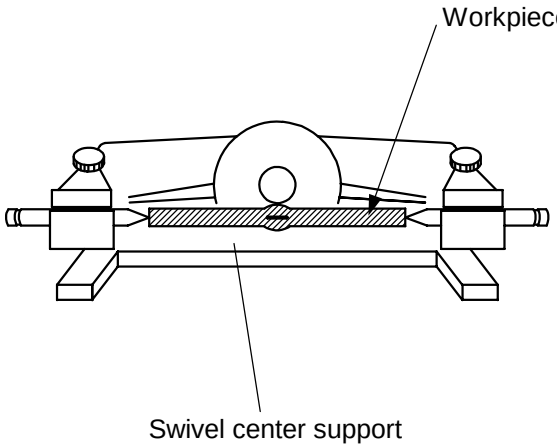
TIP The surface or contour to be projected must face the projection lens. Position the surface to be measured so that it is normal to the optical axis of the projection lens.



- For cylindrical workpieces : V-block and clamp (No. 172-378)
- For light-weight, flat workpieces which are difficult to fix : Clamp (No.176-107)



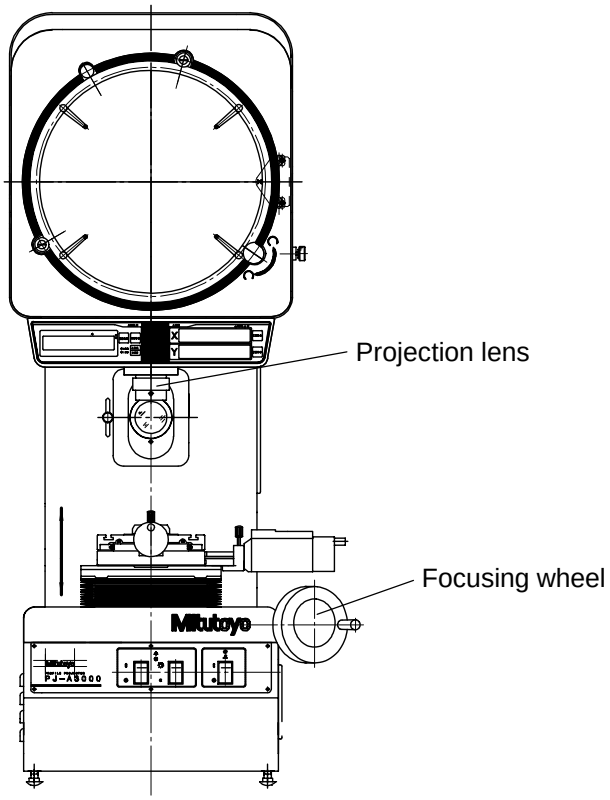
- For screws or cylindrical workpieces with center holes : Swivel center support (No.176-105, No.172-197)
- Detach the stage glass, when the Swivel center support is installed. (refer to “5.3.3”)



3.3 Focusing and Positioning the Workpiece

3.3.1 Focusing

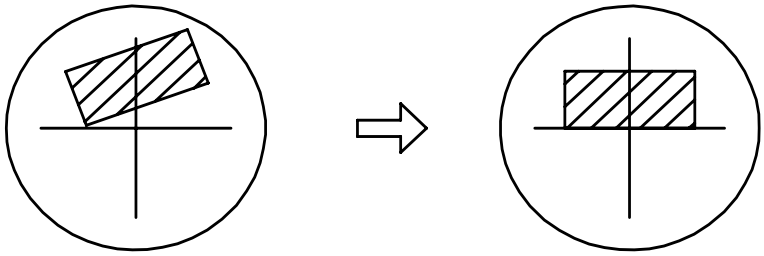
Bring the workpiece into focus by rotating the focusing wheel to move the cross-travel stage up and down.



NOTE **Be careful not to bump the Projection lens against a workpiece or fixture during focusing. Pay special attention when an stepped workpiece is mounted, or when the workpiece is supported by a swivel center support or a V-block.**

3.3.2 Positioning the workpiece

When the image is in focus on the screen, align the measured edge of the workpiece to the measuring axis of the cross-travel stage. Move the workpiece or the fixture so as to align the workpiece image with the cross-hair lines on the screen.



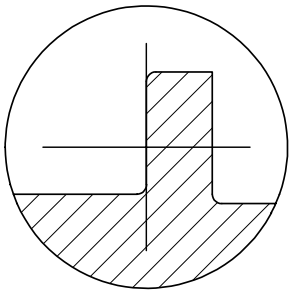
- Rotary table (No.176-106, 172-196) is suitable for performing alignment.

3.4 Measurement and Inspection

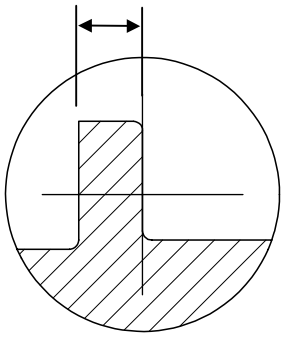
The measuring method for each application should be determined by the measurement factors involved : shape, size and quantity of workpieces, purpose, required accuracy, etc. The following methods are basic examples and can be developed further depending on the particular requirement.

3.4.1 Rectangular coordinate measurement (with the X, Y counter)

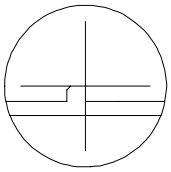
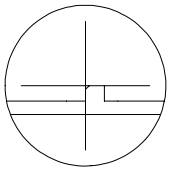
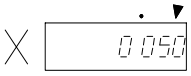
Use the cross travel of stage to make dimensional measurements.
Align the datum point of the workpiece with a cross-hair line and take a reading off the Micrometer Head or built-in counter. Move the cross-travel stage to align the point to be measured to the same cross-hair line and take a reading. The difference between the two readings is the dimension of the workpiece (or the distance between the two points).



Dimension



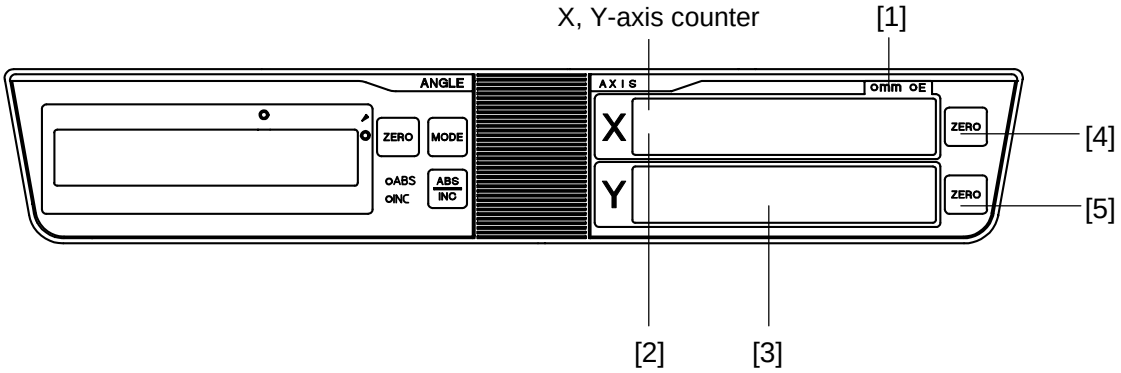
• Operation

Operation	When using the X, Y counter (PJ-A3005D, PJ-A3005F, PJ-3010F)
Move the stage so that one end of the workpiece is aligned with the cross-hair.	
Press the zero button of the X-axis to set the counter to zero.	Zero setting
Move the stage so as to align the other end of the workpiece with the cross-hair.	
Take a reading from the counter.	 Dimension is displayed

NOTE **The following procedure must be performed on the PJ-A3005D-50:**

Set the Digimaldc Head to zero when the counter has been zeroed. Otherwise, the displayed values on the counter and Digimatic Head will not be the same.

- X, Y-axis counter (PJ-A3005D-50, PJ-A3010F-100, PJ-A3005F-150, PJ-A3010F-200)



1	mm/E indicator or inch/mm indicator	The LED for the active unit is lit.		
2	X-axis counter	Resolution	PJ-A3005D	0.001 mm
			PJ-A3005F	
			PJ-A3010F	
3	Y-axis counter	Resolution	PJ-A3005D	0.001 mm
			PJ-A3005F	0.001 mm
			PJ-A3010F	0.001 mm
4	X-axis zero-set switch	Sets the X-axis counter to zero at any X-axis position of the stage.		
5	Y-axis zero-set switch	Sets the Y-axis counter to zero at any Y-axis position of the stage.		

TIP A value in units of E is displayed by dividing a displacement in units of mm by 25.4.

3.4.2 About parameters

To actually perform measurement, it is necessary to set up the count direction (count-up or count-down direction), resolution, etc. Also, if setting compensation constants for measuring errors generated according to mechanical operation and various conditions, you can make a measurement more easily and correctly. These conditions and constants are referred to as parameters. This subsection describes the function and setting procedure of each parameter.

(1) Function

Some parameters are effective for all axes and other parameters are necessary to be set for each axis. All axes is described for the parameters that are effective for all axes and Individual axis is described for the parameters to be set for each axis, respectively, in the Setting column of the following table.

No.	Parameter function	Setting
F1	Display unit [mm/E (inch)] setup	All axes Each time the Q-axis zero-set button on the counter is pressed, the count unit display LED [mm] or [E] is selected (lit) alternately.
F2.1	Count direction of X-axis(count-up or count-down direction) setup	Individual axis Each time the Q-axis zero-set button on the counter is pressed, the display of [UP] or [dn] is selected (displayed) alternately and the count direction is switched.
F2.2	Count direction of Y-axis(count-up or count-down direction) setup	
F4.1	Linear error correction value setup for X-axis	Individual axis 0 :No correction 20 :Correction value of 20mm/m 40 :Correction value of 40mm/m 80 :Correction value of 80mm/m 160 :Correction value of 160mm/m 320 :Correction value of 320mm/m -20 :Correction value of -20mm/m -40 :Correction value of -40mm/m -80 :Correction value of -80mm/m -160 :Correction value of -160mm/m -320 :Correction value of -320mm/m
F4.2	Linear error correction value setup for Y-axis	

NOTE

For the projectors of the type using Digimatic Head, pay attention to next points.

1. **Be sure to use after the setup of No. F1 parameter (setup of the display unit) and Digimatic Head are agreed.**
2. **It is not possible to reverse the counting direction by the counter, because No. F2.1 and F2.2 parameter (setup of the count direction) are invalid.**
3. **Use as correction quantity set value "0", because No. F4.1 and F4.2 parameters (linear error correction) are invalid.**

No.	Parameter function	Setting
F5	Setup for the number of smoothing times (**Smoothing** : Function to suppress flickering of the least significant digit by averaging detected values for several times of sampling, if these LED display values are difficult to read due to flickering caused by vibration, etc., of the installation site.)	All axes 1 : One time of sampling 8 : 8 times of sampling 16 : 16 times of sampling 32 : 32 times of sampling
F7.1	RS-232C communication condition setup [Baud rate]	1200 bPS : 1200 bps 2400 bPS : 2400 bps 4800 bPS : 4800 bps 9600 bPS : 9600 bps 19200 bPS : 19200 bps
F7.2	RS-232C communication condition setup [Data length]	7 b : 7 bits 8 b : 8 bits
F7.3	RS-232C communication condition setup [Parity]	non : None En : Even odd : Odd
F7.4	RS-232C communication condition setup [Stop bit]	1 b : 1 bit 2 b : 2 bits
F7.5	RS-232C communication condition setup [Flow control (Xon/Xoff)]	on : (Xon/Xoff) enabled OFF : (Xon/Xoff) disabled
F8	Setup for the number of output axes (Sets the serial output to either two-axis of X and Y or three-axis of X, Y, and Q)	2AS : X,Y-axis 3AS : X,Y,Q-axis
F9	RS-232C output format setup (Sets RS-232C data to the output format of Mitutoyo data processing unit MPK-9/7/5)	1 : MPK-9/7/5 specification 2 : Special use

For the projectors of the type using Digimatic Head, pay attention to next points.

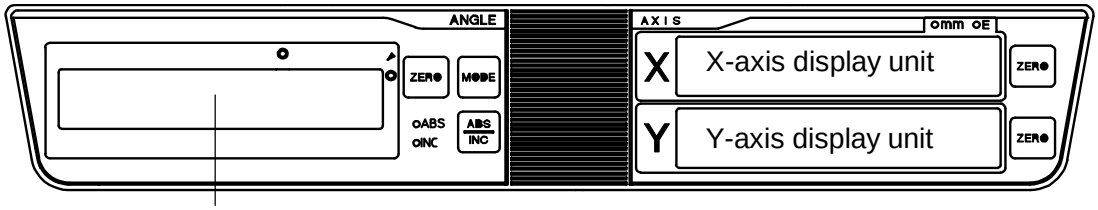
NOTE **Use as one time of sampling, because No. F5 parameter (setup for the number of smoothing times) is invalid.**

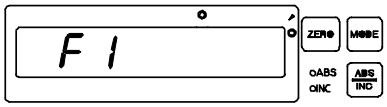
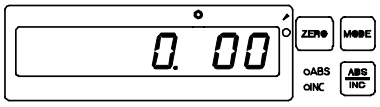
1. Use the setting "1" at No. F9 parameter. The setting "2" is the special use.

NOTE **2. No. F10 to F13 parameters are the special use.**

Don't modify the setting (the initial value is "1" for F10, "2" for F11, "1" for F12, and "1" for F13).

(2) Parameter setting procedure



Parameter setup example	Button operation	Q-axis display	Operating procedure
①Starting the parameter setup mode	MODE + ABS/INC		Hold down the “MODE” and “ABS/INC” buttons at a time more than 3 seconds.
②Switching parameters	MODE	F1 → F2.1 → · · · F8 → F9 → · · ·	Each time the “MODE” button is pressed, the parameter display changes to the next in incremental order. The parameters are looped.
③Switching parameter settings	ZERO	0.1 → 0.5 → 1.0 → 0.1 · · · (For a resolution)	Each time the Q-axis zero-set button is pressed, the parameter setting changes to the next. The parameter settings are looped.
④Exiting the parameter setup mode (Loading the set content)	MODE + ABS/INC		Hold down the “MODE” and “ABS/INC” buttons at a time more than 3 seconds.

NOTE **The set content is not memorized in the counter, if turning the power switch of projector off without performing the operation of ④. Be sure to perform the operation of ④ when setting the parameter.**

(3) Correction of the angle counter

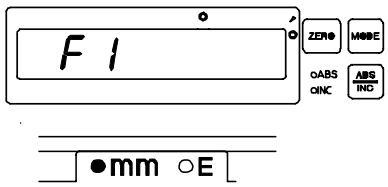
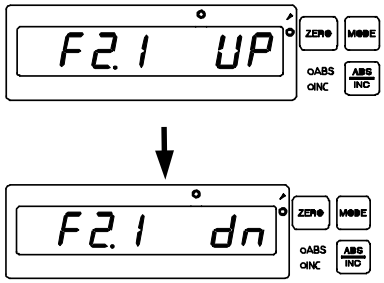
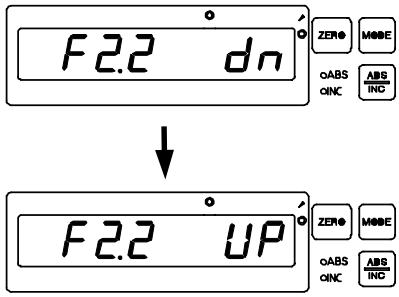
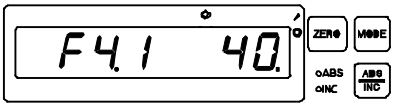
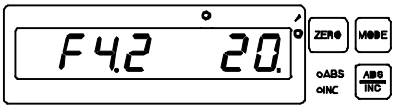
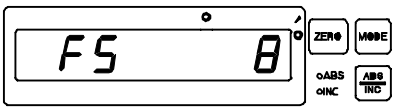
Correct the angle counter in order to perform the accurate measurement, before it is used for the first time.

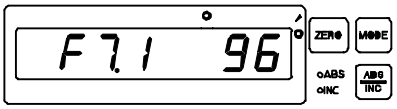
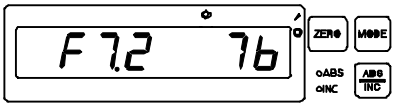
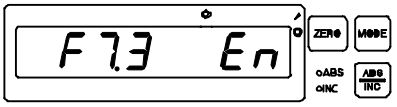
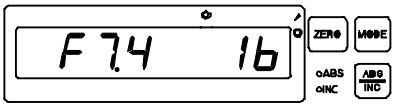
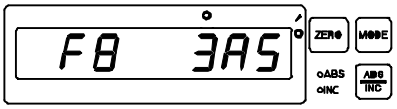
1. Turn the power switch ON, while the “ABS/INC” button of angle counter is pressed.
2. Adjust the intersection point with the cross hairs of screen glass and index to continue pressing the angle display zero-set key for about three seconds. (It is possible to perform the zero-set at the condition of ABS mode.)

3.Rotate the screen glass so that the rotation knob and the display of angle counter is counted in the plus direction. Revolve the screen glass to adjust the cross hairs of screen glass with the index once again.

4.The angle counter is corrected, when the display unit switching key and the angle display zero-set key are pressed in the condition of step 3 simultaneously. (The display is 360°00’ or 360.00°.)

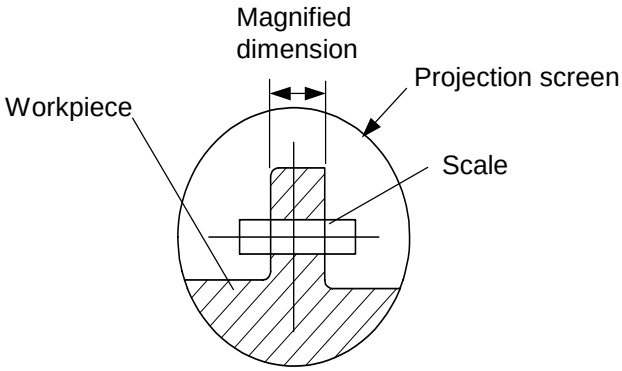
- The correction value after the correction is preserved even if the power switch is turned OFF.
- The correction is not possible, when the screen glass is rotated in the negative direction.

Parameter setup example	Button operation	Counter display	Operating procedure
Setting the display unit (Selecting mm)	MODE ZERO		1.Press the “MODE” button to select parameter [F1]. 2.Press the “ZERO” button to select [mm].
Setting the count direction (Reversing the count direction of X-axis)	MODE ZERO		1.Press the “MODE” button to select parameter [F2.1]. 2.Press the “ZERO” button to select the setting (here [dn]) unlike present setting (here [UP]).
Setting the count direction (Reversing the count direction of Y-axis)	MODE ZERO		1.Press the “MODE” button to select parameter [F2.2]. 2.Press the “ZERO” button to select the setting (here [UP]) unlike present setting (here [dn]).
Setting the linear error correction value(Selecting the X-axis correction value of 40mm/m)	MODE ZERO		1.Press the “MODE” button to select parameter [F4.1]. 2.Press the “ZERO” button to select [40].
Setting the linear error correction value(Selecting the Y-axis correction value of 20mm/m)	MODE ZERO		1.Press the “MODE” button to select parameter [F4.2]. 2.Press the “ZERO” button to select [20].
Setting the number of smoothing times(Selecting 8 times of smoothing)	MODE ZERO		1.Press the “MODE” button to select parameter [F5]. 2.Press the “ZERO” button to select [8].

Parameter setup example	Button operation	Counter display	Operating procedure
Setting the RS-232C communication condition(Selecting a baud rate of 9600bps)	MODE ZERO		1.Press the “MODE” button to select parameter [F7.1]. 2.Press the “ZERO” button to select [96].
Setting the RS-232C communication condition(Selecting a data length of 7 bits)	MODE ZERO		1.Press the “MODE” button to select parameter [F7.2]. 2.Press the “ZERO” button to select [7b].
Setting the RS-232C communication condition(Selecting the even parity)	MODE ZERO		1.Press the “MODE” button to select parameter [F7.3]. 2.Press the “ZERO” button to select [En].
Setting the RS-232C communication condition(Selecting one stop bit)	MODE ZERO		1.Press the “MODE” button to select parameter [F7.4]. 2.Press the “ZERO” button to select [1b].
Setting the RS-232C communication condition(Selecting the flow control of enabled Xon/Xoff)	MODE ZERO		1.Press the “MODE” button to select parameter [F7.5]. 2.Press the “ZERO” button to select [on].
Setting the number of output axes(Selecting 3 axes)	MODE ZERO		1.Press the “MODE” button to select parameter [F8]. 2.Press the “ZERO” button to select [3AS].

3.4.3 Dimensional measurement using a scale

Place the scale on the screen and measure the enlarged image.
Divide the measurements by the magnification of the projection lens to determine the actual dimensions.



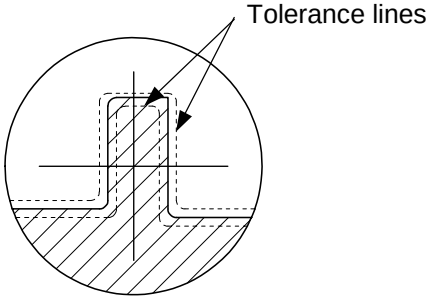
[Example]

Measured value on the screen: 150mm
Projection lens magnification: 10X
150/10=15
Actual dimension of the workpiece: 15mm

- The optional reading scale is ideal for this type of measurement because the graduated surface of the scale fits on the screen glass, providing parallax-free measurement.

3.4.4 Comparison with an overlay chart

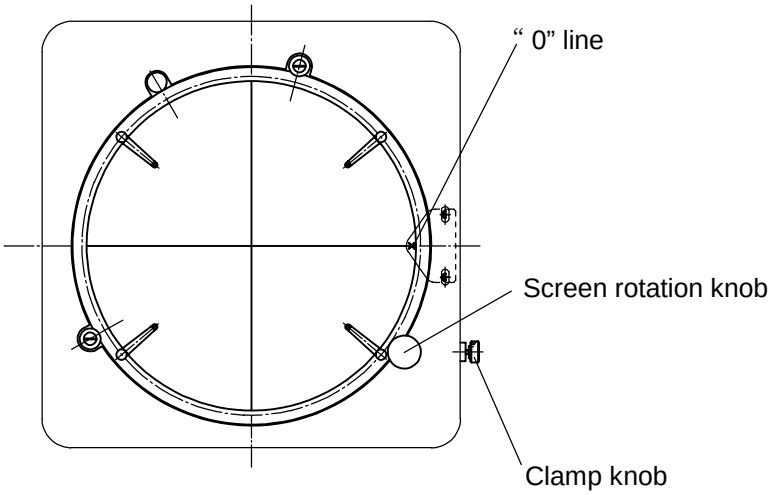
Measurement and inspection are performed by comparing the workpiece image with the standard overlay chart which is custom-made for the selected magnification. Use this method for measurement of shapes, multiple points and dimensions.
This method of measurement is suitable for checking a complicated part feature which cannot be inspected in a simple one-dimensional measurement.
Adding tolerance lines onto the standard overlay chart will improve inspection efficiency, since workpieces can be inspected with reference to these lines.
Standard charts can be made from the workpiece blue print, or the master workpiece image projected on the screen. Use transparent or semi-transparent tracing sheets(or film) to make them. For close inspection or for long-term storage, plastic tracing sheets are recommended because of their greater dimensional stability.



3.4.5 Angle measurement (Using the Angle counter)

Using the protractor screen and the rotary table for measuring angles:

- Loosen the clamp knob and use the rotation knob to turn the protractor screen.



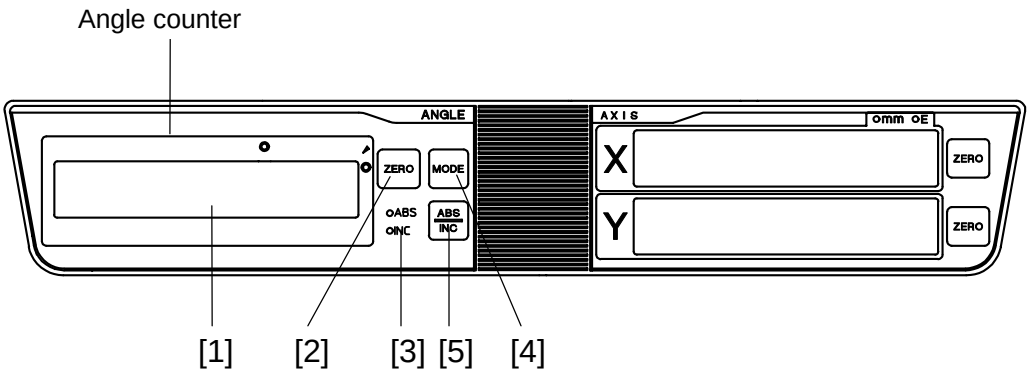
NOTE **Always use the rotation knob to rotate the protractor screen. Other methods of screen rotation may cause an error in angle measurement.**

- Angle counter

  The angle counter has two measurement modes : ABS mode for absolute measurement and INC mode for comparative measurement. Use the [ABS/INC] key to select the mode. Pressing the [ZERO] key sets the counter to zero at any angular position.

  At power on, the counter is in ABS mode with 0 being displayed. Holding down the [MODE] key for about 2 seconds can toggle the smallest unit of the angle counter between 0.0° and 1'.

  Each time the [MODE] key is pressed, the display of smallest unit is switched.



[1] Angle display

Range : ±360° (±370° in ABS mode)

Resolution : 1' (or 0.01°)

[2] Zero-set key

Sets the angle counter to zero at any position desired.

ABC mode : Hold down the key for about 3 seconds.

INC mode : Press then release the key.

[3] ABS/INC mode indicator

The LED for the active mode is lit.

[4] Angle unit selector/offset switch

Unit of angle display : Switches the smallest unit of the angle counter between 0.01° and 1'(Default is 1' at power on). For this switching hold down the switch for about 2 seconds.

Offset function : Enables an easy angle measurement. Each time the switch is pressed the displayed angle increments by 90°.

[5] ABS/INC mode selector switch

Switches between ABS and INC modes. (Default is ABS mode at power ON.)

- INC mode

Use the INC mode to perform comparative measurement. Pressing the [ABS/INC] key when in ABS mode switches to INC mode and the counter is Set to Zero.

Press the [ABS/INC] key again to return to ABS mode where the current screen angle from the datum is displayed.

- Error codes

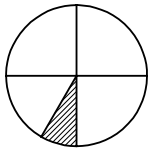
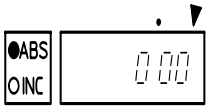
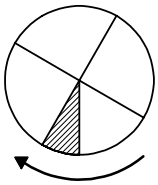
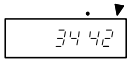
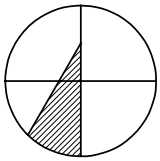
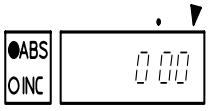
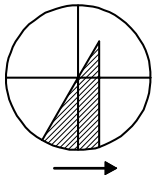
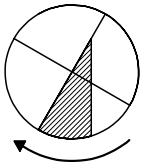
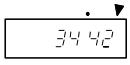
E-oF : Counter overflow

E-oS : Overspeed error

If one of the above errors are displayed, press the [ZERO] key to clear the error. Then set the datum edge again in ABS mode.

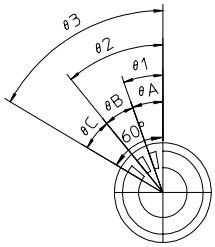
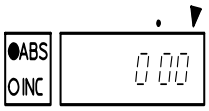
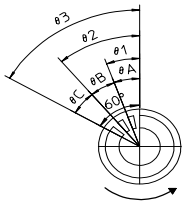
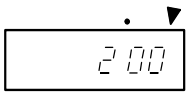
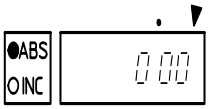
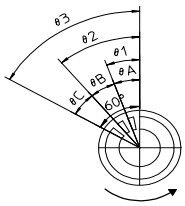
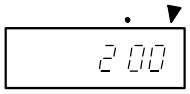
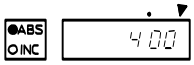
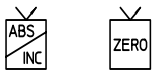
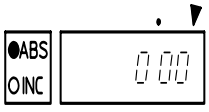
- Measuring in ABS mode

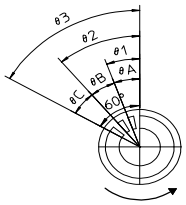
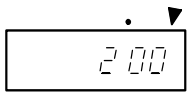
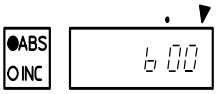
  (Angle counter setting : 1')

Step	Procedure	Screen	Counter	Display
1	Align the vertrex of the angle to be measured with the intersection of the cross-hair lines, then rotate the protractor screen to align one edge of the angle with a cross-hair line. Set the angle counter to ABS mode and establish a datum on the edge by setting the counter to Zero.		3 sec.	
2	Rotate the protractor screen to align the other edge of the angle with the same cross-hair line used in (1). The measured angle is displayed on the angle counter.		———	
1	It is also possible to measure angles by using stage cross travel to align the edges with the cross-hair lines. Align on edge of the angle with a cross-hair line. Set the angle counter to ABS mode and establish a datum on the edge by setting the counter to zero.		3 sec.	
2	Feed the stage in the X-axis direction as shown on the left.		———	———
3	Rotate the protractor screen to align the other edge of the angle with the same cross-hair line used in (1). The measured angle is displayed on the angle counter.		———	

- Measuring in ABS/INC mode

  (Angle counter setting : 1')

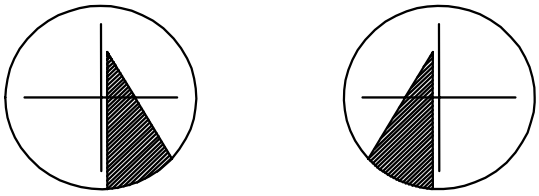
Step	Procedure	Screen	Counter	Display
1	Align a cross-hair line on the screen with the datum. Set the angle counter to ABS to mode, then set it to zero.		3 sec.	
2	Rotate the protractor screen to measure angle θ_A (=θ_1).		———	
3	Switch to INC mode to set the counter to zero.	———		
4	Rotate the protractor screen to measure angle θ_B.		———	
5	Measure θ_2. (θ_2 is displayed when switching to the ABS mode.)	———		
6	Switch to INC mode to set the counter to zero.	———		

Step	Procedure	Screen	Counter	Display
7	Rotate the protractor screen to measure θc.		———	
8	Measure θ_3. (θ_3 is displayed when switching to the ABS mode.)			

(2) Using the protractor screen and the rotary table for measuring angles:

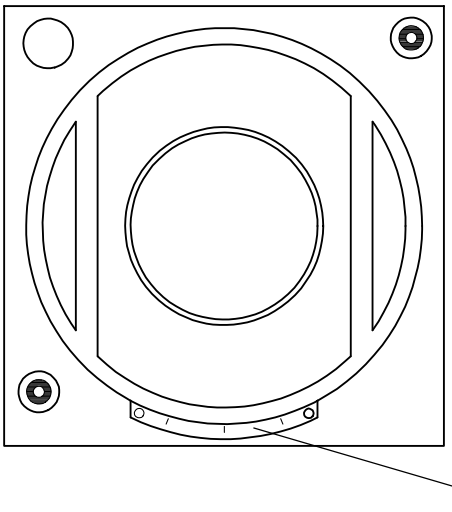
The cross travel of the stage is normally used in conjunction with the rotary movement of the table for measuring angles, because it is difficult to align the center of the rotary table with the vertex of the measured angle.

Align one of the screen cross-hair lines with an edge of the angle to be measured and read the angle. Rotate the table to align the other edge with the hair line and read its angle. the difference between the two readings represents the angle of the workpiece edge. It is not necessary for the angle vertex to remain positioned in the center for angular measurement, only that the edges be correctly aligned with the cross hair when readings are taken.



The rotary table No.172-196 can be read in 2' and No.176-106 in 6' increments (using the vernier scale).

	No.172-196	No.176-106
Diameter of the stage top	ϕ 146 mm	ϕ 112 mm
Effective diameter of the stage glass	ϕ 97 mm	ϕ 60 mm



MEMO

4 Troubleshooting

4.1 Main Unit

	Symptom	Check point	Remedy
1)	**The fan motor does not operate, even if the power switch is on.**	1)Is the power cord securely connected? 2)Is the power supply voltage consistent with the rated voltage? 3)Is the fuse OK? (not blown)	1)Connect the power cord securely. 2)Adjust the power supply voltage to the rated voltage. 3)Replace the fuse.
2)	**The transmitted illumination halogen bulb dose not light up**	1)Is the pilot lamp on? 2)Is the cable for the transmitted illuminator properly connected. 3)Is the illumination halogen bulb OK?	1)Refer to the symptom1. 2)Connect the cable properly. 3)Replace the halogen bulb.
3)	**The vertical reflected illumination halogen bulb dose not light up.**	1)Is the pilot lamp on? 2)Is the cable for the vertical reflected illuminator properly connected. 3)Is the illumination halogen bulb OK?	1)Refer to the symptom1. 2)Connect the cable properly. 3)Replace the halogen bulb.
4)	**The image is unclear.**	1)Check if the lens and workpiece are stained. 2)Check if the light intensity of the illumination is improper. 3)Check if the lens is loosened. 4)Check the environments for vibration and electric noise.	1)Clean the lens and workpiece. 2)Adjust the light intensity. 3)Tighten the lens. 4)Optimize the environmental conditions.
5)	**Abnormal sound and vibration are generated.**	1)Check if the legs on the main unit/installation stand are loose. 2)Check if the main unit/installation stand is not level.	1)Tighten the legs on the main unit/installation stand correctly. 2)Perform leveling of the main unit/installation stand.
6)	**The measurement data will not be steady.**	1)Check if the stage glass is fixed. 2)Check if the lens is loosened. 3)Check if the workpiece is fixed properly. 4)Check if the lens and glass are contaminated. 5)Check if the environmental conditions such as the temperature and vibration are within the tolerance range.	1)Fix the stage glass 2)Tighten the lens. 3)Fix the workpiece properly. 4)Clean the lens and glass. 5)Optimize the environmental conditions.

4.2 Counter Unit

	Symptom	Check point	Remedy
1)	**Nothing is displayed when the power switch is on.**	1)Is the power cord securely connected? 2)Turn the power switch off, then turn it on after at least five seconds.	1)Connect the power cord securely. 2)Try a few times. If the light still dose not come on, contact Mitutoyo.
2)	**Counter display is locked (no counting.)**	1)Turn the power switch off, then turn it on after at least 5 seconds. 2)Check the following. (Example) If the X-axis counter operates correctly and the Y-axis counter dose not, swap the X-and Y-axis Linear Scale connections. • If the same problem persists on the same counter (i.e. X-axis counter operates correctly, Y-axis counter does not operate correctly),the counter is damaged. • If the problem occurs on the other counter (i.e. X-axis counter does not operate correctly, Y-axis counter operates correctly),the Y-axis Linear Scale is damaged.	1)Try a few times. If the counter display is still locked, go to check point. 2)If the counter or any Linear Scale is found to be damaged, contact your dealer or the nearest Mitutoyo sales office.
3)	**Miscounting**	1)Is the wire from the main unit GND terminal grounded securely? 2)Is there any noise source nearby? 3)See “Counter display is locked” category in Malfunction column.	1)Securely ground the wire from the main unit GND terminal. 2)The counter should be separated by at least 0.5m from high-voltage or large-current sources and high-capacity relays. 3)If the counter or any Linear Scale is found to be damaged, contact your dealer or the nearest Mitutoyo sales office.
4)	**Count value fluctuates**	1)Are vibrations affecting the Linear Scales?	1)Take countermeasures to minimize the effects of the vibration.
5)	**Errors of "E20" and "F30" are displayed.**	1)Refer to “4.3 Error Messages and Remedies”.	
6)	**Errors of "E51" and "E52" and "E53" are displayed.**	1)Refer to “4.3 Error Messages and Remedies”. 2)Have the power switches been turned on or off according to the right column?	1)Refer to “4.3 Error Messages and Remedies”. 2)Turn the power switches on or off in the following order. ▪ For ON Peripheral equipment → Projector main unit ▪ For OFF Projector main unit → Peripheral equipment

If any other trouble than those listed above is encountered, contact your dealer or the nearest Mitutoyo service center.

4.3 Error Messages and Remedies

LED display	Meaning and remedy
E20	Overspeed arising ; Traverse speed of the axis which displayed the error is so fast. …Press the zero-set button of the axis which displayed the error or restart the microscope main unit.
F30	Overcount arising ; The scale of the axis which displayed the error exceeds the possible counting range. …Return the scale of the axis which displayed the error to the possible counting range or restart the microscope main unit.
ES1	RS232C parity error …Press the X-axis zero-set button. Restart both of the equipment connected with the counter at RS232C and the microscope main unit, when the communication is not resumed.
ES2	RS232C over-run error …Press the X-axis zero-set button. Restart both of the equipment connected with the counter at RS232C and the microscope main unit, when the communication is not resumed.
ES3	RS232C framing error …Press the X-axis zero-set button. Restart both of the equipment connected with the counter at RS232C and the microscope main unit, when the communication is not resumed.

TIP When an error code has been cleared (power is turned on), the counter displays all zeros. Perform measurement from the start.

If there is play or abnormal noise present, contact Mitutoyo. Do not disassemble the unit or unit or force the wheel.

4.4 Others

4.4.1 Error is observed in glass scale or overlay chart measurement.

This may be a magnification error. Check the magnification accuracy by referring to 2.4.6. Contact Mitutoyo if adjustment or repair is required.

4.4.2 Abnormal cross-travel stage operation, and measurement errors occur.

Check the cross-travel stage operation by referring to 2.4.7 and 2.4.8. Contact Mitutoyo if adjustment or repair is required.

4.4.3 Abnormal protractor screen operation.

If the screen rotation, fine adjustment, or clamp dose not work normally, contact Mitutoyo. Do not force them.

4.4.4 Partial obscured image.

Check the following points. Contact Mitutoyo when required depending on the problem:

(1) Is the projection lens properly mounted?
(2) Focusing
(3) Oil stains on the workpiece or stage glass
(4) Stains or damage to the projection lens
(5) Stains or damage to the surface reflecting mirror

4.4.5 Digimatic Head Key Operation and Counter Display (for PJ-A3005D-50)

Digimatic Head	**Counter**
Press the [+/-] key.	The sign changes.
Press the [RESET] key. Start of presetting (“P” blinks).	“E81” is displayed.
Press the [ZERO/ABS] key ① ZERO ② ABS	① “0.000” is displayed. ② The value displayed on the Digimatic Head is displayed.
Press the [ON/OF] key ① OFF ② ABS	① “E81” is displayed. ② “0.000” is displayed.

5 Maintenance

This chapter explains the daily maintenance that must be performed on the Measuring Projector PJ-A3000 series, including cleaning and the replacement of consumable parts.

5.1 Maintenance of Optical Components

5.1.1 Projection lens

Compared with ordinary hard glass, the optical glass of the projection lens used for the projector is soft and subject to scratches. In order to remove dust do not use a cloth to wipe the lens, but use a blower brush instead.
To remove oil or fingerprints, dampen clean gauze with a mixture of high-grade alcohol and ether in a ratio of 8 to 2, and wipe gently using a circular motion.
For lens storage, replace the lens cap and store it in its case.
Also replace the lens cap when the projector is not in use, although the lens does not have to be removed from the projector.

5.1.2 Half-reflecting mirror for surface illuminator

The half mirror for 10x and 20X is coated with a plastic film which tends to collect dust. Since the mirror surface is subject to scratches, take sufficient care when handling it. Use a blower brush to remove any dust from the mirror.

5.1.3 Mirror (surface reflecting mirror)

Since the mirror used in the projector is silvered on its front face rather than on its back, unlike ordinary mirrors, it is highly subject to scratches. Ensure it is free from dust or oil. Should the mirror become stained, use the same cleaning procedure as for the projection lens. Greater precautions, however, are required for handling the mirror.

5.1.4 Screen glass

Use a soft cloth with diluted neutral detergent and wipe the glass when removing oil and finger print. After wiping, remove the detergent by wiping with a soft cloth soaked with water.

5.2 Maintenance of Mechanical Components

5.2.1 Projector main unit

Periodically lubricate the feed screws and gears for the cross-travel stage vertical travel. To do so, open the door at the right front of the projector, and apply a thin coat of grease using a brush. Take care to keep the grease away from other parts of the projector interior, especially the bulbs.

5.2.2 Cross-travel stage

Remove the cross-travel stage from the stage mount, and apply a small amount of spindle oil to the V-groove guide rail. Use a soft, dry cloth to wipe dust off the stage glass and clean the glass gently with thinners or alcohol.

5.3. Replacing Disposable Parts

5.3.1 Bulbs for contour and surface illuminators

CUTION

1. To prevent personal injury, do not touch a hot bulb during use or immediately after tuning it off.

2. To prevent the bulb from being stained with oil or fingerprints, do not touch the bulb with your hand.

3. Do not apply force to the bulb pin in the horizontal direction, or the bulb could be destroyed.

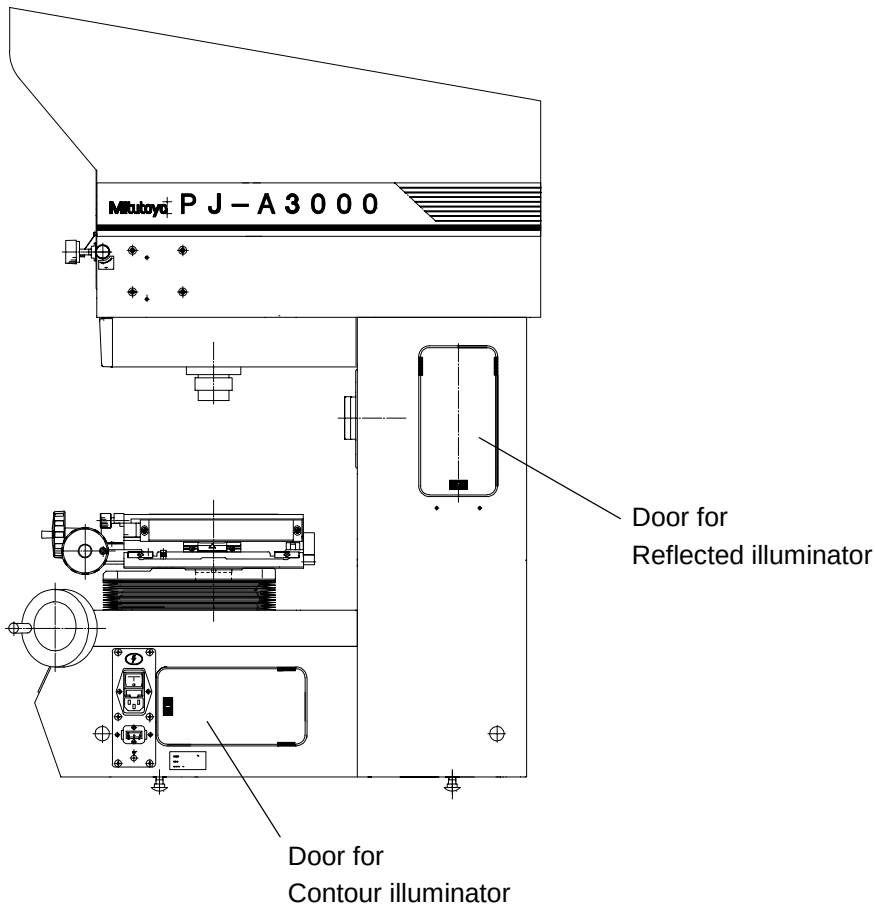
▪ Replacing a bulb

(1) Turn off the contour and reflected illumination switches.

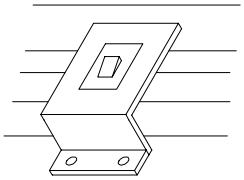
(2) Turn the main switch off.

(3) Open the door at the right front of the projector.

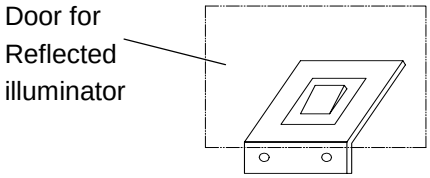
(4) Pull out the bulb adapter plate.



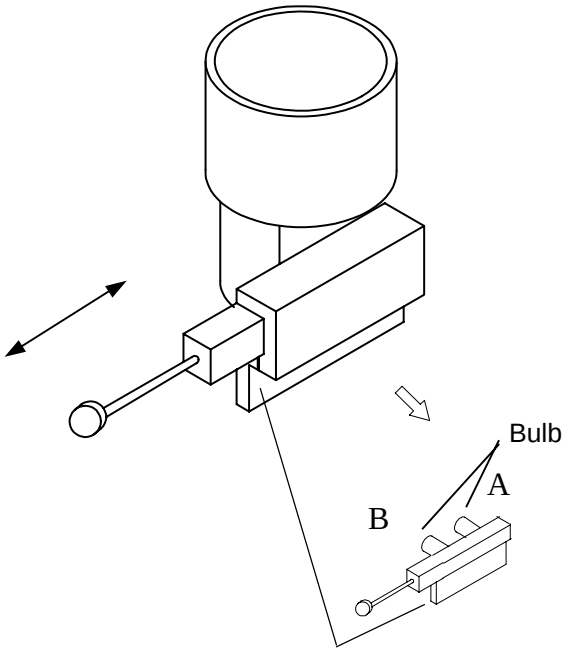
NOTE **Each two bulbs can be mounted to each illuminator after opening the doors for contour and reflected illumination. Slide the bulb adapter plate to the click position, when the one of the two's bulb is blown. Tilt each illumination bulb selection switch to the rear side, when the bulb A is lit. Tilt each illumination bulb selection switch to the front side, when the bulb B is lit.**



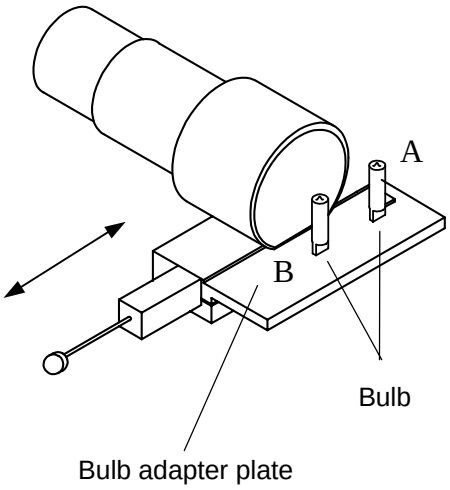
Contour illumination



Reflected illumination

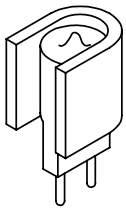


Bulb adapter plate

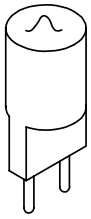


(5) The bulb becomes considerable high temperature just after it is blown. Grasp the bulb so that it's tube wall may not be touched directly, and pull it straight from the bulb adapter plate, when the bulb is removed.

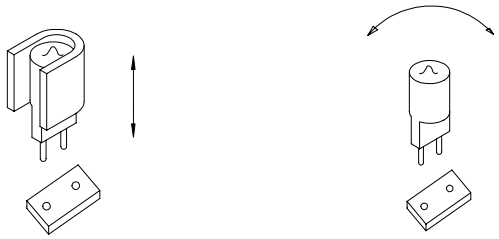
OK



NG



(6) To mount the bulb, insert it straight into the socket as far as it can go so that the bulb filament image is centered in the convex mirror.



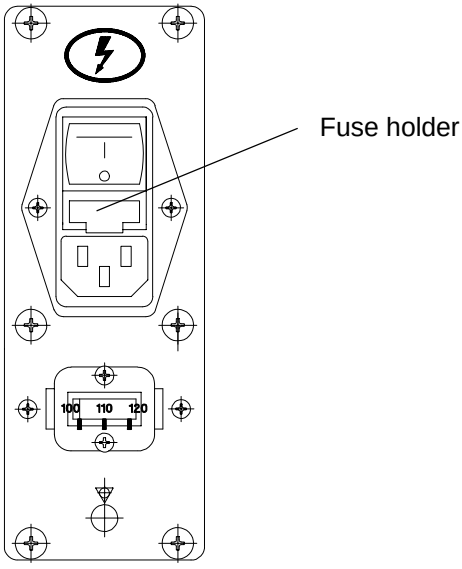
(7) To mount the bulb, insert it straight into the socket as far as it can go so that the bulb filament image is centered in the convex mirror.

5.3.2 Fuse

1. Take out the fuse holder on the main unit rear panel and replace the fuse with a new one as follows.

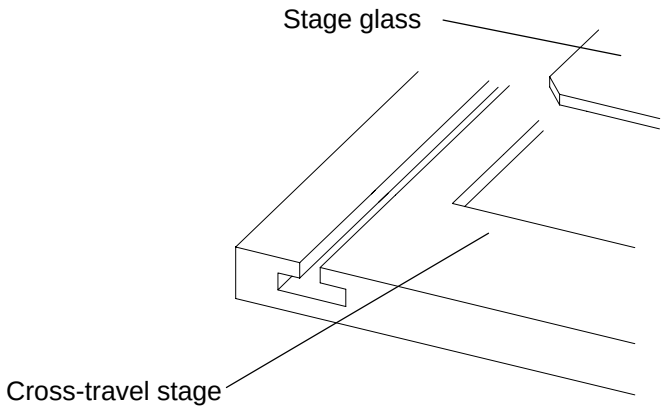
2. Pull out the fuse from the holder and replace a new one.

3. Insert the fuse holder in the case until it clicks.



5.3.3 Stage glass

1. While pushing the stage glass toward the projector rear, lift the front part of the glass to remove it.
(For PJ-3005D, remove the glass fixing screw.)



2. Mount the new stage glass

CUTION

The X-Y stage glass is held in place by a leaf spring. Be careful not to lose this spring.

5.4 Periodic Inspection

To ensure a long working life of the projector, perform periodic inspection, cleaning and oiling of the projector components. Refer to 2.3 for a list of inspection items. Refer to 5.1 and 5.2 for cleaning and lubrication.

5.5 List of Consumable

Order No.	Part name	Remark	
512305	Halogen bulb	24V-150W	(Life : 500 hours)
515530	Halogen bulb	24V-150W	(Life : 50 hours)
384211	Tube fuse	BS SEMKO S506 5A (for 200V-system region)	
12BAE152		51MS080H 8A	(for 100V-system region)
200673	Stage glass for PJ-A3000	Dimensions	ϕ 80mm
		Effective area	ϕ 70mm
380405	Stage glass for PJ-A3005R-50	Dimensions	110 X 96mm (4.33 X 3.78")
		Effective area	82 X 82mm (3.23 X 3.23")
380405	Stage glass for PJ-A3005D-50	Dimensions	110 X 96mm (4.33 X 3.78")
		Effective area	82 X 82mm (3.23 X 3.23")
12BAE041	Stage glass for PJ-A3010F-100	Dimensions	154 X 154mm (6.06 X 6.06")
		Effective area	142 X 142mm (5.59 X 5.59")
381349	Stage glass for PJ-A3005F-150	Dimensions	196 X 96mm (7.72 X 3.78")
		Effective area	184 X 82mm (7.24 X 3.23)
382762	Stage glass for PJ-A3010F-200	Dimensions	280 X 180mm (11.02 X 7.09")
		Effective area	266 X 170mm (10.47 X 6.69)

MEMO

6 Specifications

6.1 General

6.1.1 Common specifications

1. Protractor screen
Effective measurement diameter: ϕ315mm (12.4")
Angle display: Digital
Measuring range: ±360°

2. Projection lens
10X (Standard accessory)
20X, 50X, 100X (Optional accessory)

3. Illumination unit
•Contour illumination :
Telecentric illumination with 2-stage intensity selector, Halogen bulb(built-in): 24V 150W, Average life 500 hours
•Reflected illumination :
Vertical and oblique surface illumination, Halogen bulb(built-in): 24V 150W, Average life:500 hours

4. Magnification accuracy
•Contour illumination : ±0.1 % or less
•Reflected illumination : ±0.15% or less

5. Power supply
Specification for the 100 V-system region : 100,110,120VAC (50/60Hz)
Specification for the 200 V-system region : 220,230,240VAC (50/60Hz)

6. Environmental conditions

Temperature(in operation) : 0 to 40°C

Humidity(in operation) : 20 to 80%

Dust : The same conditions as for measurement rooms

7. Dimensions

W X D X H : 400 X 742 X 1093mm (15.75 X 29.21 X 43.03”)

Screen center height : 854mm (33.62”)

6.1.2 Individual specifications

Order No.	inch/ mm	302-711	302-712	302-713	302-714	—	—	—	302-718	302-719	—
	mm/E	302-701	302-702	302-703	302-704	302-705	302-706	302-707	302-708	302-709	302-700
Model No.		PJ -A3010F -200	PJ -A3005F -150	PJ -A3010F -100	PJ -A3005D -50	PJ -A3010F -200E	PJ -A3005F -150E	PJ -A3010F -100E	PJ -A3005D -50E	PJ -A3005R -50	PJ -A3000
1)Cross-travel stage	Traverse range (X × Y)(mm)	200 X 100 (7.87 X 3.94")	150X50 (5.91 X 1.97")	100 X 100 (3.94 X 3.94)	50X50 (1.97 X 1.97")	200 X 100 (7.87 X 3.94")	150X50 (5.91 X 1.97")	100 X 100 (3.94 X 3.94)	50X50 (1.97 X 1.97")	50X50 (1.97 X 1.97")	Fixed
	Stage size (mm)	430 X 250	280 X 152	250 X 250	152 X 152	380 X 250	280 X 152	250 X 250	152 X 152	152 X 152	145 X 120
	Effective stage glass size (mm)	266 X 170	184 X 82	142 X 142	82 X 82	266 X 170	184 X 82	142 X 142	82 X 82	82 X 82	ϕ70
	Height (mm)	75.5	64.5	77	44.5	75.5	64.5	77	44.5	44.5	44.5
2) Measuring device		Linear encoder			Digima-tic Head	Linear encoder			Digima-tic Head	Mecha-nical head	—
3)Built-in XY counter	Resolution	1 μm				—					
	Display range	±999.999 mm									
	Functions	Zero setting Count direction inch/mm selection				—					—
	Data output system	RS232C				SPC					None
	Data output axis	X, Y-axis/ Angle				Angle					None
4) Maximum workpiece height (mm) (Design standard value)		92.5	103.5	91	123.5	92.5	103.5	91	123.5	123.5	123.5
5) Mass (kg)		140	116	112	107	140	116	112	107	106	105

6.1.3 Date output (RS232C)

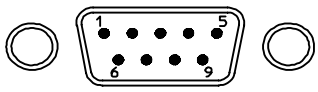
For the projector equipped with the RS232C port, the measured date of the counter unit is output via the serial output connector to a peripheral, such as two-dimensional data processing unit Micropak 9/7 or QM-DATA or two-dimensional data processing program 2Dpak or QSPAK.

Communication Specifications

- Transmission method: Half duplex
- Transmission control: Asynchronous (Start-stop transmission)
- Baud rate:1200bps/2400bps/4800bps/9600bps(*1)/19200bps
- Data bit:7 bits(*1)/8 bits ASCII
- Parity bit: Even(*1)/Odd/None
- Stop bit:1 bit(*1)/2 bits
- Flow control: Enabled/Disabled(*1)

(*1) Default setting at the shipment

6.1.4 Connector specifications

Connector shape	Pin number	Signal	I/O direction *2	Description
 D-sub, 9 pins, male, inch thread	1			
	2	RD	IN	Accept the command
	3	TD	OUT	Measured data
	4	DTR	OUT	Counter is ready
	5	SG	-	Signal ground
	6	DSR	IN	Peripheral is ready
	7	-	-	
	8	-	-	
	9			
	FG	-	-	Frame ground

(*2) In/Out direction OUT: counter → Peripheral

The input/output circuits used are equivalent to MAX232 (MAXIM Corporation).

Control signal

A data request from a peripheral is accepted only if the DTR signal is “H” (space). “H” has a +9V level.

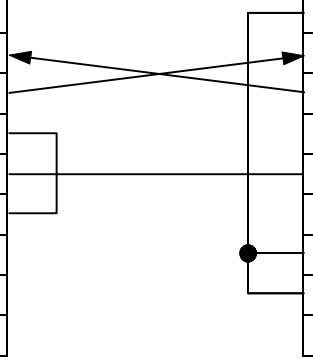
The counter unit can transfer only if the DSR signal is “H” (space).

Example of cable that can be used

The following illustrates two types of reference cables which are used to connect the counter to a DOS/V PC. One of the cables does not use control lines and other uses control lines.

Cable 1 (Control lines are not used)

Pin No.	Signal name
1	N.C
2	RD
3	TD
4	DTR
5	SG
6	DSR
7	N.C
8	N.C
9	N.C

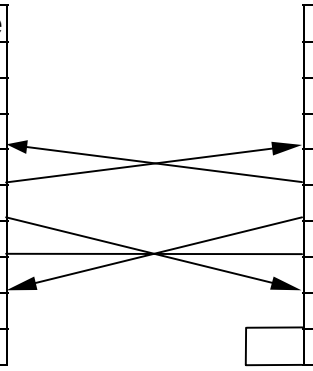


Pin No.	Signal name
1	DCD
2	RXD
3	TXD
4	DTR
5	GND
6	DSR
7	RTS
8	CTS
9	RI

[Counter unit] **[DOS/V]**

Cable 2 (Control lines are used)

Pin No.	Signal name
1	N.C
2	RD
3	TD
4	DTR
5	SG
6	DSR
7	N.C
8	N.C
9	N.C



Pin No.	Signal name
1	DCD
2	RXD
3	TXD
4	DTR
5	GND
6	DSR
7	RTS
8	CTS
9	RI

[Counter unit] **[DOS/V]**

6.1.5 Data output operation

A displayed value on the counter unit can be output by inputting an external load signal or commands from a peripheral, such as a personal computer.

(1) Data output

A) For the external load signal

Only the data on the axis on which the external load box switch is pressed is output to a peripheral.

B) For the command from peripheral

Data is output to a peripheral by inputting the following character strings (commands) from the peripheral, such as a personal computer.

List of command from peripheral

(Only the half angle capital letter is accepted.)

Input command				Output data
X	CR	LF		X-axis data
Y	CR	LF		Y-axis data
Q	CR	LF		Q-axis data
A	CR	LF		X, Y-axis data
A	Q	CR	LF	X, Y, Q-axis data
C	0	CR	LF	None

∗C0 (zero) command is for the error clear.

(2) Output format

The Output data is output in the specified format.

Below are given output examples of various kinds of data for a signal-axis counter and multi-axes counter.

1) Single-axis counter output

A) If “345.678” is displayed on the X-axis counter:

X		+	0	3	4	5	.	6	7	8	CR	LF

B) If “0.0000” is displayed on the Y-axis counter:

Y		+	0	0	0	0	.	0	0	0	CR	LF

C) If “ -180° 50’ ” is displayed on the Q-axis counter: (equal to ABS/INC)

Q		-	1	8	0	.	5	0	CR	LF

If “ -180.50° ” is displayed on the Q-axis counter: (equal to ABS/INC)

Q		-	1	8	0	.	5	0	CR	LF

2) Multi-axes counter output

A coordinate data of each axis is the same as the output format of a single-axis counter.

For one-axis)

Q-axis data	CR	LF

For two-axes)

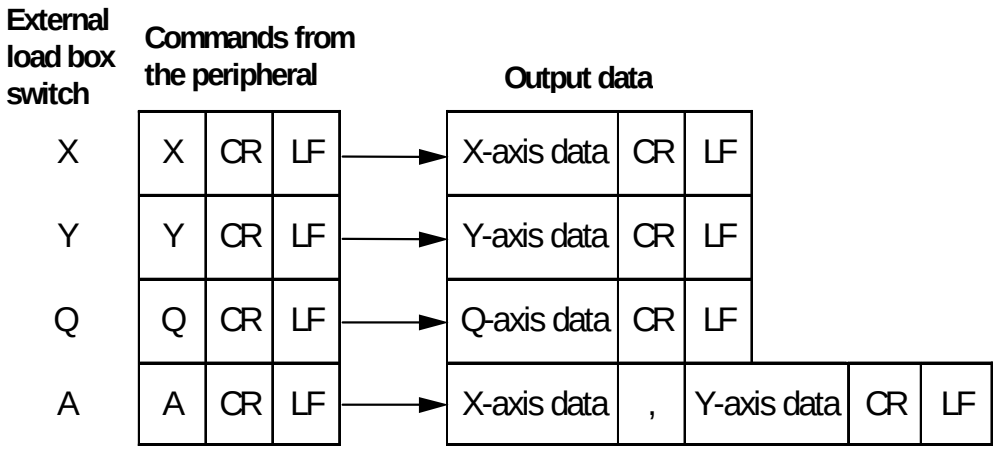
X-axis data	,	Y-axis data	CR	LF

For three-axes)

X-axis data	,	Y-axis data	,	Q-axis data	CR	LF

3) Summary of external device data and output data

By pressing the switch on the external load box or upon reception of commands from the peripheral, the counter unit outputs the following data.



4) Error

Next error code is output, when the error arises in the counter.

RS232C error code	Display	Error cause	Remedy (method of return)
N G 0 5 CR LF	**E51**	Parity error arising	1)Press the X-axis zero-set button. 2)Transmit C0 (zero) command from the peripheral equipment at RS232C.
N G 0 7 CR LF	**E52**	Over-run error arising	
N G 0 8 CR LF	**E53**	framing error arising	
N G 0 9 CR LF	-	Receiving the un-defined command	Correspond by the normal command.
X E 2 0 CR LF	**E20**	X-axis overspeed arising	1)Press the X-axis zero-set button. 2)Transmit C0 (zero) command.
Y E 2 0 CR LF	**E20**	Y-axis overspeed arising	1)Press the Y-axis zero-set button. 2)Transmit C0 (zero) command.
Q E 2 0 CR LF	**E-oS**	Q-axis overspeed arising	1)Press the Q-axis zero-set button. 2)Transmit C0 (zero) command.
X F 3 0 CR LF	**F30**	X-axis overcount arising	Return to the range in which the counting is possible.
Y F 3 0 CR LF	**F30**	Y-axis overcount arising	
Q F 3 0 CR LF	**E-oF**	Q-axis overcount arising	1)Press the Q-axis zero-set button. 2)Return to the range in which the counting is possible.

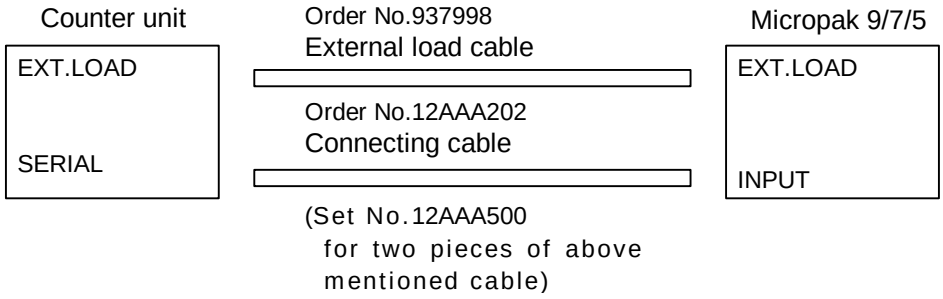
TIP The error with high priority is displayed, when the multiple error phenomena arises simultaneously. If the error is canceled by C0 (zero) command, etc., the error with next high priority is displayed.

6.1.6 Connecting Micropak

It is necessary to perform the Micropak 9 / 7 / 5 setting when connecting the Micropak to the counter unit.

For information about setting up Micropak 9 / 7 / 5, refer to the Micropak user's manual.

(1) Connection



(2) Micropak 9/7 setup

①Set Equipment--> Counter--> Baud Rate--> 9600 bps

②Set Equipment--> Counter--> X-axis Counter--> RS-232C Connection
Y-axis Counter--> RS-232C Connection
Z-axis Counter--> RS-232C Connection

③Set Equipment--> Counter--> Counter connected--> MF

④Set Conditions--> Measuring Rang--> X Y Z

(3) Micropak 5 setup

Set the Dip switch DPS1 and DPS2 according to the following.

①DPS1 No.1 : ON, No.2 : OFF, No.3 : OFF, No.4 : OFF 4800bps

②DPS2 No.5 : ON, No.6 : OFF

Modify also the parameter setup of the counter simultaneously. (Set "4800bPS" at the parameter number F7-1 according to "3.4.2 About parameters".)

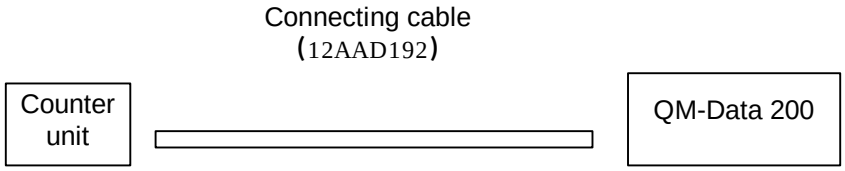
(Note)

To connect the counter to Micropak 5, unless the default setting are modified, the counter cannot be connected to Micropak 5. (Because MPK-5 does not accept the Q-axis data.)
Modify also the parameter setup of the counter so that Q-axis output may not be performed. (Set "2 AS" at the parameter number F8 according to "3.4.2 About parameters".)

6.1.7 Connecting QM-Data 200

It is necessary to perform the QM-Data 200 setting when connecting it to the counter unit. For information about setting up QM-Data 200, refer to it's user's manual.

(1) Connection



(2) QM-Data 200 setup

① Select "SYSTEM" key of operation panel.

② Measuring Instrument Setting--> Counter Type--> Profile Projector with RS Output

After the selection, the communication condition of QM-Data 200 becomes as follows.

- Baud rate 9600bps
- Data bits 7bit
- Parity Even
- Stop bits 1bit
- Flow control None

NOTE **When QM-Data 200 starts, the counter display of projector fades away and LED of inch/mm display at the counter blinks on and off. The switches on the projector counter become ineffective.**

6.1.8 Data output (SPC)

While the projector may be used on a stand alone basis, it also has the capability of transmitting data to external devices through the counter. Incorporating the projector into the M-SPC(Mitutoyo Statistical Process Control) system permits measurements from the projector to be statistically analyzed in order to create histograms and process control charts, etc. Data output from the counter is initiated on the connected processor such as Digimatic Data-Processor. Measurement data displayed on the counter will be transmitted.

If the projector is being used with a data processor, output data may not be consistent with the displayed values when the counter is set to zero.

(1) OUTPUT connector specification

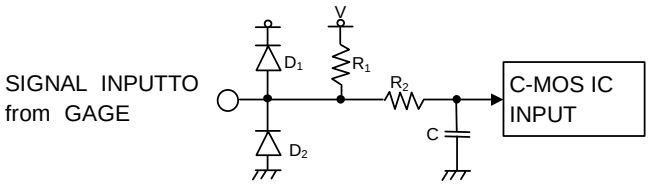
- Applicable SPC cable : P/N : 965013
- IN/OUT direction OUT : Counter → Connected device

Pin number	Signal	I/O direction	Description
1	GND(Logic)		Grounded
2*1	DATA	OUT	Measured data
3*1	CK	OUT	Clock for data transmission
4	N.C		Not used
5*2	REQ	IN	Request to send
6-9	N.C		Not used
10	GND(Logic)		Grounded

*1 Open collector : 5.25V, 10mA max

*2 C-MOS：Raised to Vcc(+5V)

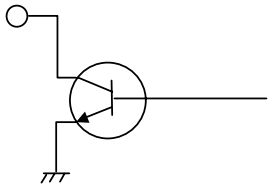
TYPE A Input circuitry : DATA
CK



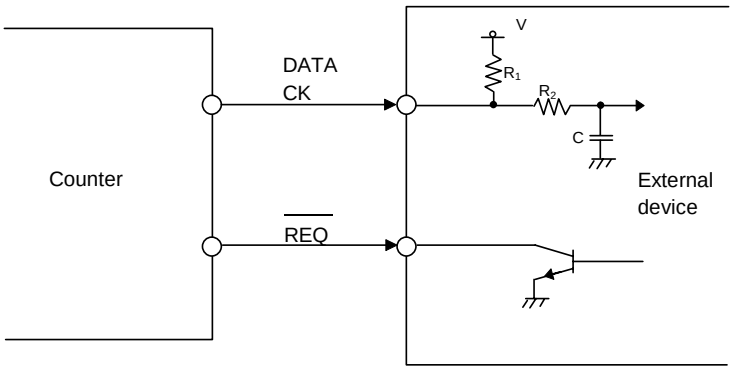
R_1,R_2	=22kΩ	±10%
C	=330ph	+30% -20%
D_1,D_2	=1S1588 (or equivalent)	

TYPE A Output circuitry : $\overline{\text{REQ}}$

SIGNAL INPUTTO to GAGE
(OPEN-COLLECTOR)



NPN TYPE transistor 2SC2855 (or equivalent)
or TTLIC(WITH OPEN-COLLECTOR TYPE)



*The constants for R1 and R2 are different from the above values, depending on the device connected. Set the correct constants by consulting the reference manual of the connected device.

(2) Output data format

Each measurement is transmitted as 13-digit serial data. Each digit consists of a 4-bit data that represents 0 to F(hexadecimal). Output is sequential starting with the LSB(least significant bit). The table on the right shows the assignments of the 13 digits.

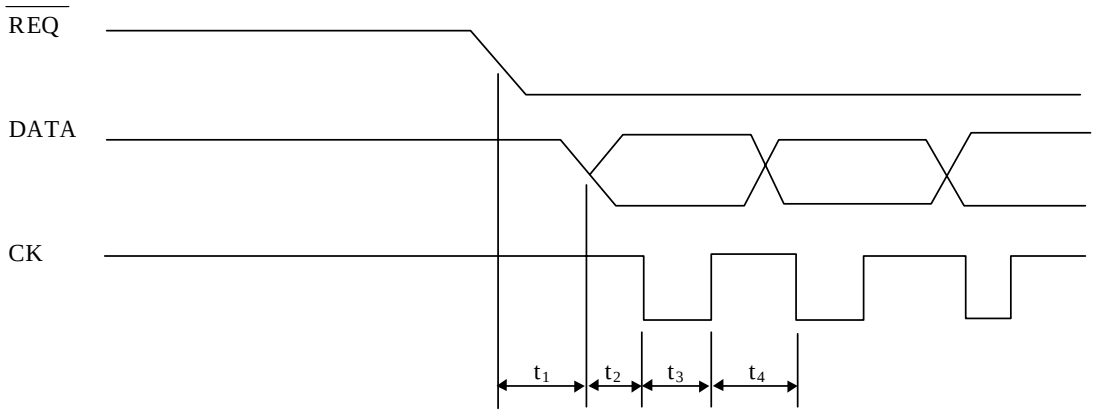
Example of output data

d1	d2	d3	d4	d5	d6	d7	d8	d9	d10	d11	d12	d13
F	F	F	F	8	0	1	2	3	4	5	3	0

d5 d6~d11 d12 d13
$-012345x10^{-3}$mm $\rightarrow$ -12.345mm

Digit	Assignment	Data
d1 d2 d3 d4	Not used	F(1111) F(1111) F(1111) F(1111)
d5	Sign	+ : 0(0000) - : 8(0001)
d6 d7 d8 d9 d10 d11	Measured data (6-digit BCD)	MSD (most significant digit) ⋮ LSD (least significant digit)
d12	Magnification	$x10^{-0}$: 0(0000) $x10^{-1}$: 1(0000) ⋮ $x10^{-5}$: 5(1010)
d13	Unit	mm : 0(0000) inch : 1(1000)

(3) Timing chart

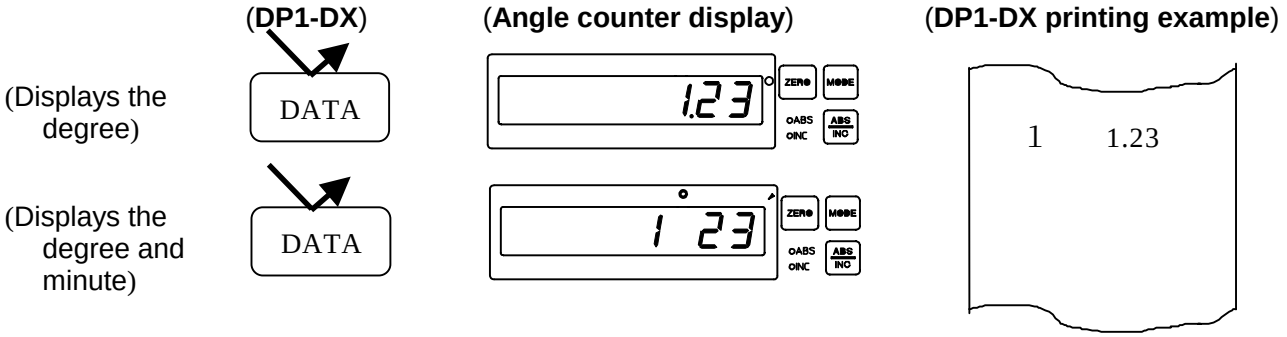


$10ms \leq t_1 \leq 2s$
$150\ \mu s \leq t_2 \leq 200\ \mu s$
$150\ \mu s \leq t_3 \leq 400\ \mu s$
$150\ \mu s \leq t_4 \leq 400\ \mu s$

(4) DP-1 printing example

Referring to DP1-DX, the printing example is shown as follows.

The value of angle counter is output and printed, when DP1-DX data key is pressed.



(**Note**) 1.System of units of angle are not printed.

2. When displaying **°**', the result is not correct if the statistics calculation is performed on the basis of output value. Therefore, perform with **.**° display of decimal notation.

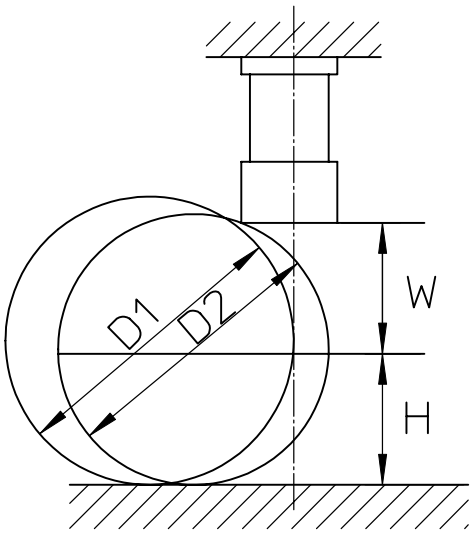
3. The * mark, etc. are printed when the communication error arises. Perform the error release with DP1 clear key, etc..

4. For a part of DP1-VR model, there is a case in which the unit of inch is printed. In this case, set up no unit printing according to DP1-VR user's manual.

6.2 Performance Table for the PJ-A3000 Series Projectors

(Unit : mm)

		Contour illumination				Reflected illumination			
Magnification		10X	20X	50X	100X	10X	20X	50X	100X
Field of view		31.5	15.7	6.3	3.1	31.5	15.7	6.3	3.1
Working distance	W	66	32.5	12.6	5	20	2	12.6	5
PJ-A3000	H	123.5	123.5	123.5	123.5	123.5	123.5	123.5	123.5
	D1	224	87	27	10	198	61	27	10
	D2	154	69	25	10	120	23	25	10
PJ-A3005R-50	H	123.5	123.5	123.5	123.5	123.5	123.5	123.5	123.5
	D1	224	87	27	10	198	61	27	10
	D2	154	69	25	10	120	23	25	10
PJ-A3005D-50	H	123.5	123.5	123.5	123.5	123.5	123.5	123.5	123.5
	D1	224	87	27	10	198	61	27	10
	D2	154	69	25	10	120	24	25	10
PJ-A3010F-100	H	91	91	91	91	91	91	91	91
	D1	182	87	27	10	182	61	27	10
	D2	154	69	25	10	120	23	25	10
PJ-A3005F-150	H	103.5	103.5	103.5	103.5	103.5	103.5	103.5	103.5
	D1	207	87	27	10	198	61	27	10
	D2	154	69	25	10	120	23	25	10
PJ-A3010F-200	H	92.5	92.5	92.5	92.5	92.5	92.5	92.5	92.5
	D1	185	87	27	10	185	61	27	10
	D2	154	69	25	10	120	23	25	10

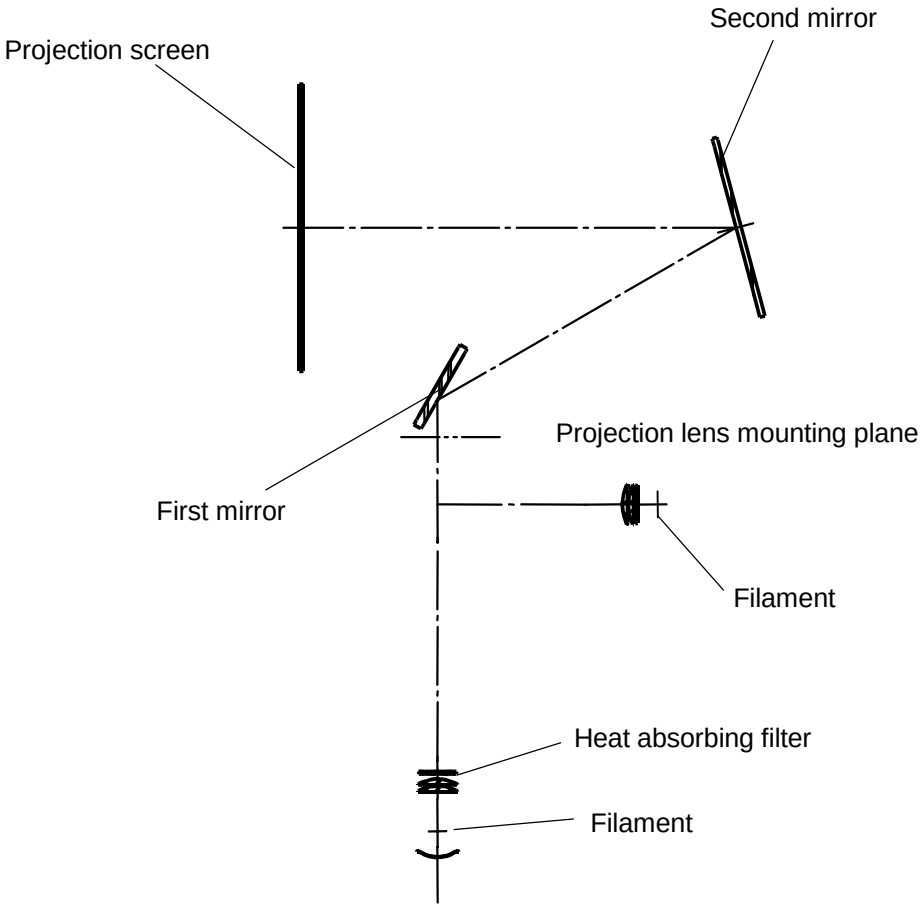


H : Maximum workpiece height

D1 : Maximum diameter of cylinder whose edge is projected on the screen center

D2 : Maximum diameter of cylinder whose edge is projected on the screen edge

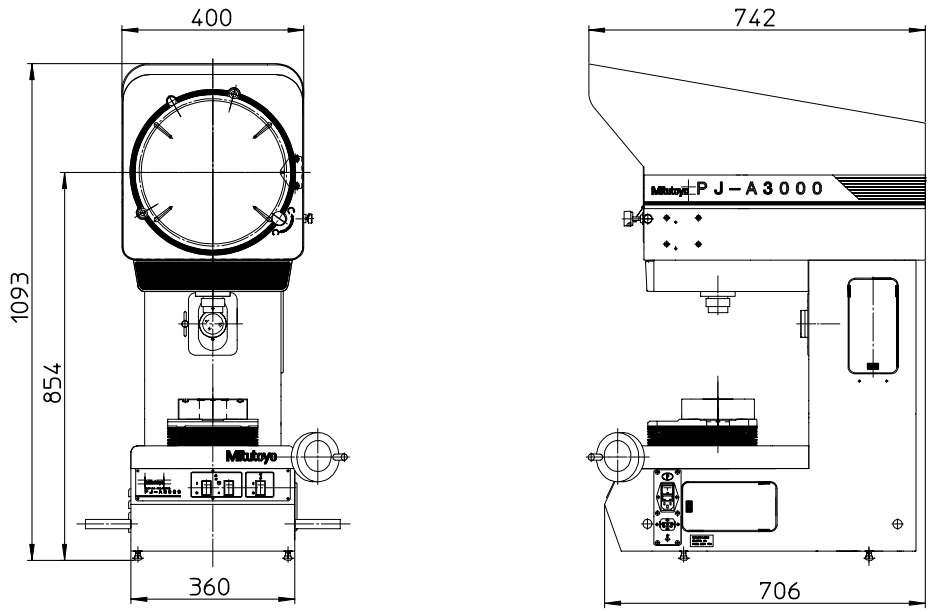
6.3 Optical Path



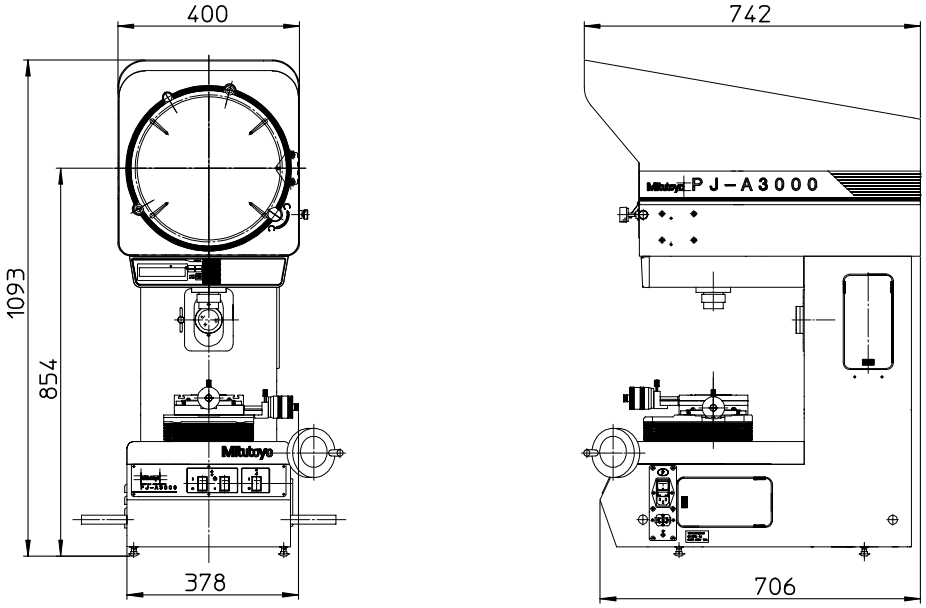
6.4 External dimensions

6.4.2 Main Unit

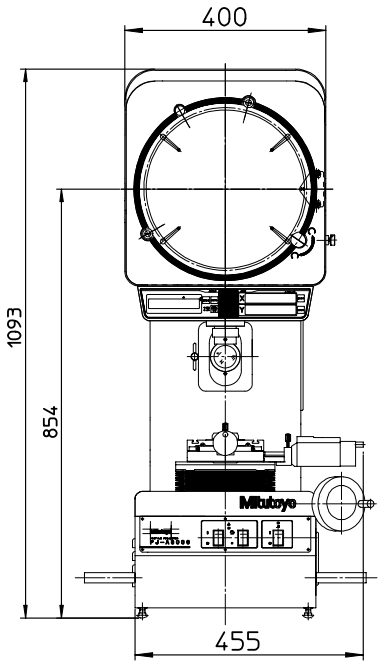
PJ-A3000

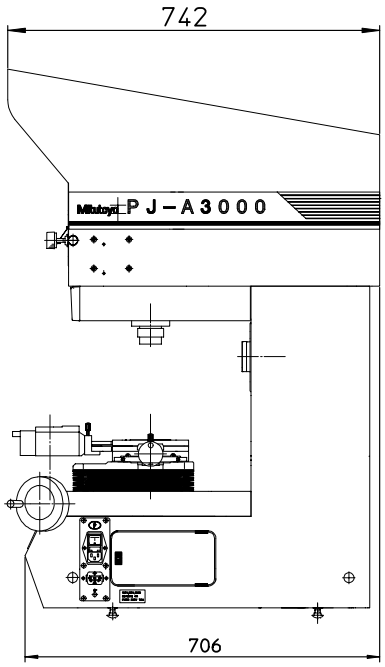


PJ-A3005R-50

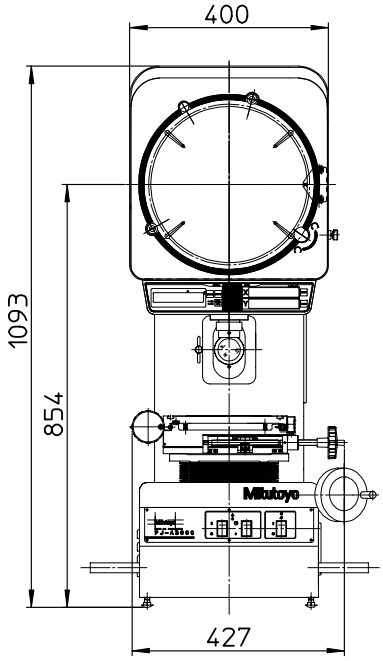


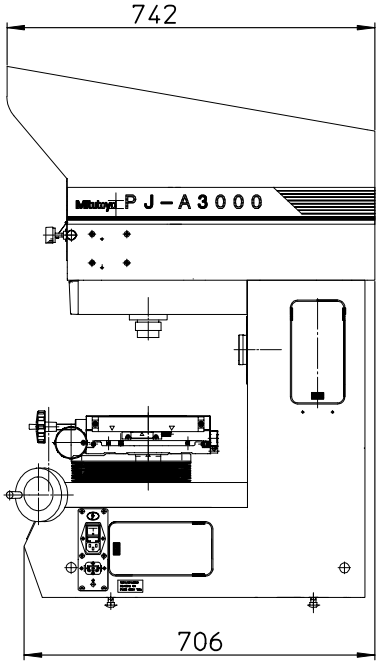
PJ-A3005D-50



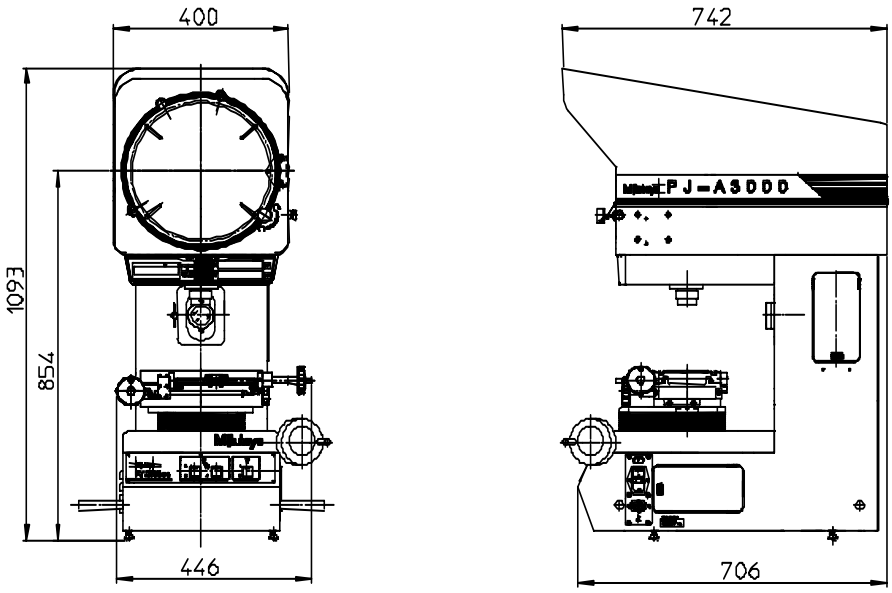


PJ-A3010F-100

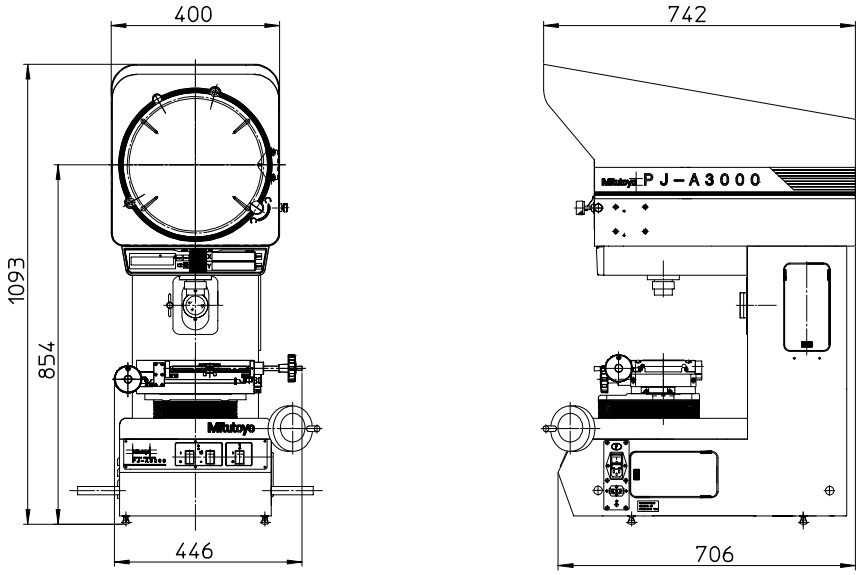




PJ-A3005F-150

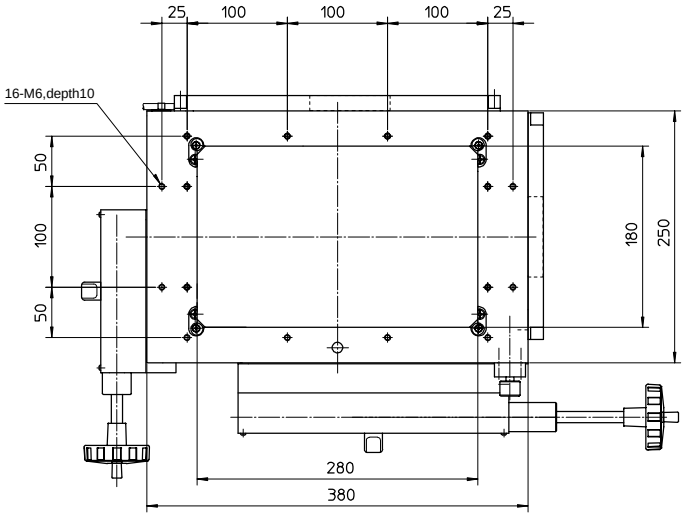


PJ-A3010F-200

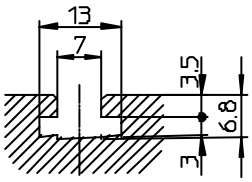


6.4.2 Cross-travel stage

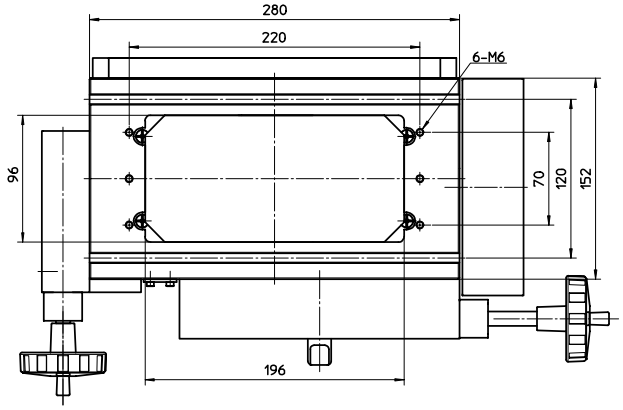
Traverse range : 200X100



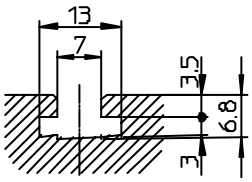
Traverse range : 150X50



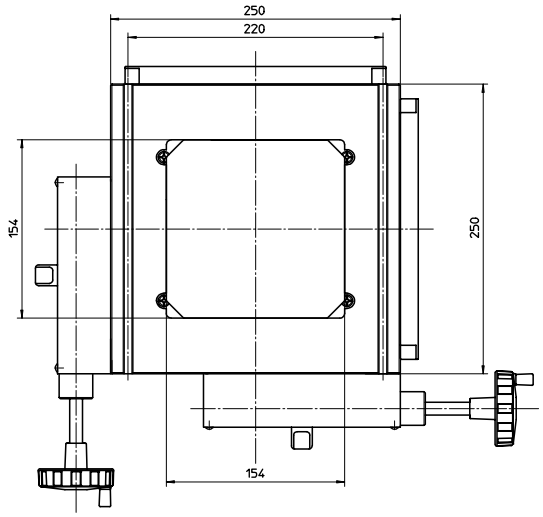
Detailed drawing of T-groove



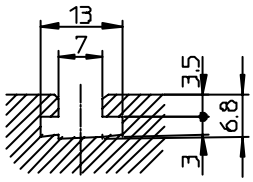
Traverse range : 100X100



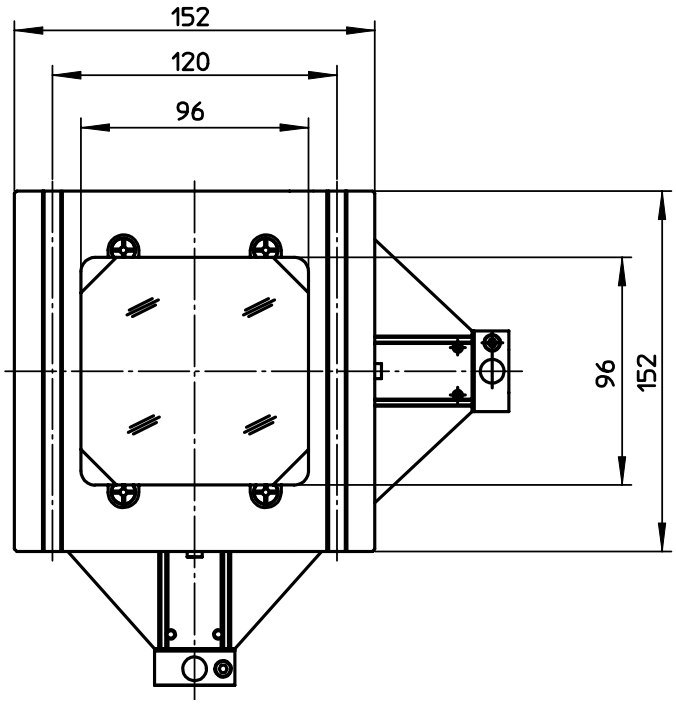
Detailed drawing of T-groove



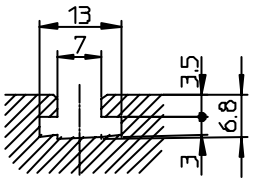
Traverse range : 50X50



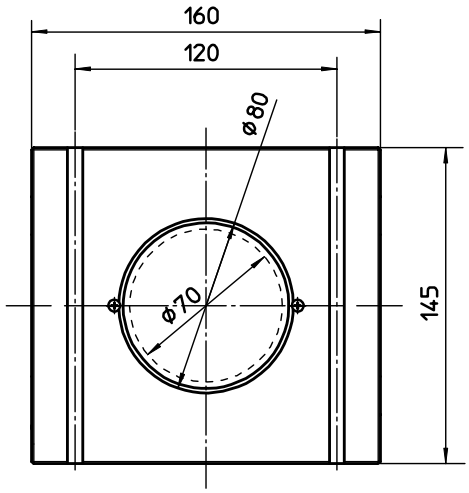
Detailed drawing of T-groove



Fixed stage



Detailed drawing of T-groove



6.5 Accessories

6.5.1 Standard accessories

Order No.	Part Name	Quantity	Model No.					
			PJ-A3010F --200,-200E	PJ-A3005F -150,-150E	PJ-A3010F -100,-100E	PJ-A3005D -50,-50E	PJ-A3005R -50	PJ-A3000
172-202	Projection lens 10x set	1	○	○	○	○	○	○
930919	Shield plate	1	○	○	○	○	○	○
930966	Power cord AC100 to 120V	1 (Select any one kind)	○	○	○	○	○	○
930967	Power cord AC220 to 240V							
998614	Power cord AC220 to 240V							
512305	Halogen bulb 24V150W500H	3	○	○	○	○	○	○
384211	Tube fuse BS SEMKO S506 5A	2 (Select any one kind)	○	○	○	○	○	○
12BAE152	Tube fuse 51MS080H							
3020-1180-32	Grounding wire	1 (Select any one kind)	○	○	○	○	○	○
990784	Grounding wire							
383876	Vinyl cover	1	○	○	○	○	○	○
538616	Alley spanner nominal 3	1	○	○	○	○	○	○
538615	Alley spanner nominal 2.5	1	○	○	○	○	○	○
512926	Cap	4	○	○	○	○	○	○
99MBA043A	Operation Manual (this paper)	1	○	○	○	○	○	○
472730	Warranty (large)	1	○	○	○	○	○	○
359151	Spanner for leveling	1	○	○	○	○	○	○

6.5.2 Optional accessories

Order No.	Part Name	Quantity	Model No.					
			PJ-A3010F -200 / PJ-A3010F -200E	PJ-A3005F -150 / PJ-A3005F -150E	PJ-A3010F -100 / PJ-A3010F -100E	PJ-A3005D -50 / PJ-A3005D -50E	PJ-A3005R -50	PJ-A3000
172-203	Projection lens 20x set	1	○	○	○	○	○	○
172-204	Projection lens 50x set (with hart-reflecting mirror)	1	○	○	○	○	○	○
172-207	Projection lens 100x set (with hart-reflecting mirror)	1	○	○	○	○	○	○
172-229	Oblique reflecting mirror(10x)	1	○	○	○	○	○	○
172-230	Oblique reflecting mirror(20x)	1	○	○	○	○	○	○
172-116(172-117)	Standard scale (50mm or 2")	1	○	○	○	○	○	○
172-118(172-119)	Reading scale (200 mm or 8")	1	○	○	○	○	○	○
172-161(172-162)	Reading scale (300 mm or 12")	1	○	○	○	○	○	○
172-160-2	Color filter	1				○	○	○
■ 172-160-3	Color filter	1	○	○	○			
176-106	Rotary table	1		○		○	○	○
172-196	Rotary table	1	■○	○	○			
176-105	Swivel center support	1				○	○	○
172-197	Swivel center support	1	■○	○	○			
176-107	Holder with clamp	1	■○	○	○	○	○	○
172-378	V block and clamp	1	■○	○	○	○	○	○
✸ 514304	Attachment board for Optoeye sensor (with screws)	1	○	○	○			
✸ 332-115-1	Optoeye A2	1	○	○	○			
✸ 264-140,-00,-01	QM-Data-200	1 (Select any one kind)	○ / ○	○ / ○	○ / ○	○ / A○		
✸ 264-141,-00,-01	QM-Data-200		○ / ○	○ / ○	○ / ○	/ A○		
12AAD192	Connecting cable	1	○	○	○	○		
# 999678	Adapter	1	○					
515530	Halogen bulb 24V 150W 50H	1	○	○	○	○	○	○

Note)

- **For PJ-A3000, ✸ mark can't be mounted to them.**
- **When the ■ mark is used, will be simultaneous with #mark Adapter(No.999678).**
- **For PJ-A3005D-50E with A mark, I/F(MUX-10F), etc. which convert SPC output into RS232C are necessity.**

Order No.	Part Name	Quanti-ty	Model No.					
			PJ-A3010F-200 / PJ-A3010F-200E	PJ-A3005F-150 / PJ-A3005F-150E	PJ-A3010F-100 / PJ-A3010F-100E	PJ-A3005D-50 / PJ-A3005D-50E	PJ-A3005R-50	PJ-A3000
12BAE137	Scratch resistance stage glass (50X50)	1				○	○	
12BAE138	Scratch resistance stage glass (100X100)	1			○			
12BAE139	Scratch resistance stage glass (150X50)	1		○				
12BAE140	Scratch resistance stage glass (200X100)	1	○					
12BAE141	Scratch resistance stage glass (Fixed stage)	1						○
172-269	Machine stand	1	○	○	○	○	○	○
172-267	Machine stand	1	○	○	○	○	○	○
965013	SPC cable (2m)	2						
			D○	D○	D○	D○		
174-103-13	KS counter	1	C○	C○	C○			
			○	○	○			
174-123-13	KC counter	1	C○	C○	C○			
			○	○	○			
12AAC038	2Dpak-M	1	○	○	○			
12AAC035	2Dpak-P	1						
						B○		

Note)

- **For PJ-A3005D-50E with B mark, connect with the output cable of MHD to it.**
- **For PJ-A3010F-200 and PJ-A3005F-150 and PJ-3010F-100 with C mark, use by reconnecting Linear Scale with the external counter.**
- **D mark is for an angle counter output.**

Order No.	Part Name	Quanti-ty	Model No.					
			PJ-A3010F -200 PJ-A3010F -200E	PJ-A3005F -150 PJ-A3005F -150E	PJ-A3010F -100 PJ-A3010F -100E	PJ-A3005D -50 PJ-A3005D -50E	PJ-A3005 R -50	PJ-A3000
512066	Overlay chart	1	○	○	○	○	○	○
512067	Overlay chart	1						
512069	Overlay chart	1						
512070	Overlay chart	1						
512071	Overlay chart	1						
512072	Overlay chart	1						
512073	Overlay chart	1						
512074	Overlay chart	1						
512075	Overlay chart	1						
512076	Overlay chart	1						
512077	Overlay chart	1						
932105	Overlay chart	1						
12BAE144	Overlay chart (Continuous line and Staggered cross-hair line)	1						